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System Description Document Cover Sheet

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9. Remarks

The title of this document is *Waste Emplacement System Description Document.*

This document is a two volume document. Block 1 indicates the number of pages in Volume I. Block 4 indicates the numver of pages in Volume I plus Volume II.

Final issued approved document

The following TBD/TBVs are contained in this document:

TBD-240	TBV-254
TBD-241	TBV-257
TBD-249	TBV-259
TBD-250	TBV-265
TBD-251	TBV-268
TBD-252	TBV-269
TBD-253	TBV-270
TBD-254	TBV-271
TBD-255	TBV-272
TBD-256	TBV-273
TBD-257	TBV-274
TBD-258	
TBD-259	
TBD-269	
TBD-320	
TBV-246	
TBV-248	
TBV-251	
TBV-252	
TBV-253	

Use additional sheets if necessary.

CRWMS/M&O	**System Description Document Revision Record** *Complete only applicable items*	QA: 1. Page 1 of 25

2. SDD Title	
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TABLE OF CONTENTS

SUMMARY

The Waste Emplacement System transports the loaded and sealed Disposal Container (DC) from the Waste Handling Building (WHB) to the subsurface area of emplacement. This system operates on the surface between the North Portal and the WHB, and in the underground Ramps, Access Mains, and emplacement drifts. This system accepts the loaded DC onto a reusable rail car, moves the DC into the shielded transporter, transports the DC to the emplacement area, and emplaces the DC in the emplacement drift. The operation cycle is completed when the transport equipment returns to the surface WHB to receive another DC.

Major items and sub-systems of the Waste Emplacement System consist of the following:

- A shielded transporter with a reusable rail car for the movement and transfer of the DCs. The transporter requires transport locomotives for movement.
- Transport locomotives for the transporter movement and control functions between the WHB and the subsurface repository.
- A remotely controlled emplacement gantry for the DC emplacement functions in the emplacement drifts. The gantry is self powered through a direct current third rail system.
- A gantry carrier for gantry transfer between the emplacement drifts and/or to the maintenance facilities. The gantry carrier requires a transport locomotive for the carrier movement and control functions.

The sequence of the subsurface DC handling process is as follows;

The DC, positioned on a reusable rail car, is moved into the shielded transporter at the surface WHB. A remotely controlled loading mechanism moves the rail car into and out of the transporter. The loading mechanism will be an integral part of the transporter.

A pair of transport locomotives is used to move the transporter from the WHB, into and down the North Ramp, into the East or West Main, and to the vicinity of the designated emplacement drift. At the pre-selected emplacement drift location, one locomotive is uncoupled to allow the transporter, with the transporter doors facing the drift entrance, to be pushed into the emplacement drift turnout. Before the transporter is pushed into the turnout, the locomotive operators leave the locomotive, and the following functions of the emplacement sequence are performed remotely. Once the transporter is partway in the turnout, the transporter doors and the drift isolation doors open remotely, then the transporter is pushed into contact with the Subsurface Emplacement Transportation System drift transfer dock.

Once the transporter is docked, the unloading mechanism moves the reusable rail car with the DC out of the transporter and onto the rails located on the transfer dock. The emplacement gantry (gantry) moves into position over the DC, it engages the DC by the skirts at both ends, and raises the DC off the reusable rail car. The gantry carries the DC into the emplacement drift, stopping at a pre-determined emplacement position. The DC is lowered onto permanently installed pedestals. The gantry disengages from the DC and moves back to its waiting position at the transfer dock. These operations are reversible to support moving an emplaced DC to another location.

The transporter retracts the reusable rail car, and is pulled away from the drift entrance doors by a locomotive. The transporter doors and the drift doors are then closed, and the transporter returns to the surface WHB for another transport and emplacement operation. The transporter may also receive a DC onto the reusable rail car from the emplacement gantry to support moving the DC to another emplacement drift or to the surface WHB.

The system interfaces with other MGDS subsystems, including the following;

- Disposal Containers for receiving, transport, emplacement, or removal operations.
- Ventilation System for drift operating environment.
- Isolation doors at the WHB, dock and rails.
- Subsurface Emplacement Transportation System, which provides the rail, rail switching and control, rail electrification systems, and the emplacement drift transfer docks. This system provides DC electric power to Waste Emplacement System equipment.
- Ex-Container DC Supports in the emplacement drifts which receive the DC from the Waste Emplacement System gantry.
- Ground Control System for equipment clearances in the ramps, access mains, turnouts, and emplacement drifts.
- DC Handling System to load the DC on the reusable railcar.
- Monitoring and Control Systems for remote control operations of locomotives and gantries.
- Subsurface Safety & Monitoring System, Subsurface Operational Monitoring System, and the Central Command and Control System to provide monitoring and control of system operations.

QUALITY ASSURANCE

The Quality Assurance (QA) program applies to this document. This activity can impact the proper functioning of the MGDS waste package. The *Q-List* has identified the Waste Emplacement System as an MGDS item Important to Radiological Safety (QA-1), Important to Radioactive Waste Control (QA-3), Important to Potential Interaction (QA-5), and Important to Occupational Radiological Exposure (QA-7). The MGDS Requirements Manager has evaluated this activity in accordance with QAP-2-0, *Conduct of Activities*. The *SDD Development/Maintenance* activity evaluation has determined the preparation, checking, and review of this document to be subject to *Quality Assurance Requirements and Description* requirements. Unverified and undetermined criteria and engineering data are identified and tracked, in accordance with NLP-3-15, *To Be Verified (TBV) and To Be Determined (TBD) Monitoring System*. This document was prepared in accordance with NLP-3-33, *System Description Documents*.

1.0 FUNCTIONS AND DESIGN CRITERIA

The functions and design criteria for the system are identified in the following sections. Throughout this document the term "system" shall be used to indicate the Waste Emplacement System.

1.1 SYSTEM FUNCTIONS

1.1.1 The system receives a loaded and sealed disposal container at the Waste Handling Building.

1.1.2 The system transports and emplaces disposal containers containing Uncanistered SNF (Spent Nuclear Fuel), Canistered SNF, Defense High Level Waste, and DOE Waste Forms.

1.1.3 The system emplaces the disposal container in its final location within the drift.

1.1.4 The system removes disposal containers for performance confirmation and relocates disposal containers for thermal load management, if required.

1.1.5 The system provides remote control capabilities for waste transportation, emplacement, recovery, and removal operations.

1.1.6 The system provides operators with remote visual surveillance of all waste transportation and emplacement operations.

1.1.7 The system interfaces with other MGDS systems for support in waste handling, transport, and emplacement operations.

1.1.8 The system provides shielding or other methods for isolating radioactive sources from workers.

1.1.9 The system performs required operations during and after occurrences of Design Bases Events.

1.1.10 The system provides mechanisms and safety features to reduce the potential for accidents involving the disposal container.

1.1.11 The system provides features to support safe operations by personnel and to protect equipment from damage.

1.1.12 The system operates within the surface, subsurface, and induced environmental conditions expected at the site.

1.1.13 The system allows for routine testing and maintenance.

1.1.14 The system limits handling loads applied to the disposal container during loading, unloading, subsurface transport, and drift emplacement.

1.1.15 The system operates within the physical envelopes provided by the Ground Control System and the Subsurface Facility System.

1.2 SYSTEM DESIGN CRITERIA

This section presents the design criteria for the Waste Emplacement System. Each, criteria in this section has a corresponding Criteria Basis Statement in Volume II (see Section 5) that describes the need for the criteria as well as a basis for the performance parameters imposed by the criteria. Each criterion in this section also contains bracketed traces indicating traceability to the functions (F) in Section 1.1; the *Controlled Design Assumptions Document* (CDA); the *Mined Geologic Disposal System Requirements Document* (MGDS RD); and Title 10, Part 60 of the Code of Federal Regulations, *Disposal of High Level Wastes in Geologic Repositories* (10CFR60).

1.2.1 System Performance

1.2.1.1 The system shall have a minimum operational life of 40 years following the start of emplacement.

[F 1.1.1][MGDS RD 3.2.B, 3.2.H]

1.2.1.2 The system shall be capable of transporting and emplacing disposal containers with a maximum annual throughput rate of 524 (TBV-257) disposal containers per year over the emplacement period.

[F 1.1.1, F 1.1.2, F 1.1.3][MGDS RD 3.2.D][CDA Key 003]

1.2.1.3 The system shall transport disposal containers by rail from the Waste Handling Building to the emplacement drift entrance within the subsurface repository over a maximum distance of 10 km.

[F 1.1.2]

1.2.1.4 The system shall transport and emplace disposal containers over a maximum grade of +/-2.5%, between the surface and the emplacement drift and a maximum grade of +/-1% within the emplacement drifts.

[F 1.1.2]

1.2.1.5 The system shall be capable of remote emplacement of disposal containers into emplacement drifts having a maximum drift length of 700 meters.

[F 1.1.3, F 1.1.5]

1.2.1.6 The system shall be capable of transporting and emplacing a maximum of 11,000 disposal containers over the life of the system.

[F 1.1.2, F 1.1.3][MGDS RD 3.2.B]

1.2.1.7 The system shall transport and emplace disposal containers with the characteristics defined in Table 1.

Table 1 Disposal Container Characteristics

Length	3.700 to 6.200 m (TBV-246)
Diameter	1.250 to 2.000 m (TBV-246)
Weight	83,000 kg (TBV-246) maximum
Radiation Levels	317 rem/hr (TBV-248) or less
Heat Output	18 kW (TBV-251) or less

[F 1.1.2, F 1.1.3][CDA EBDRD 3.7.1.J.1, 3.7.1.J.2]

1.2.1.8 The system shall provide for horizontal emplacement of disposal containers on a support system at a specified location within the emplacement drift with a tolerance of (TBD-249) m of the emplacement drift axial location.

[F 1.1.3]

1.2.1.9 The system shall be capable of removing (TBD-250) (quantity/time period) intact emplaced disposal containers and transporting each disposal container to a surface location (TBD-250) within (TBD-250) hours.

[F 1.1.4]

1.2.1.10 The system shall be capable of relocating (TBD-253) (quantity/time period) of emplaced disposal containers from the emplacement location to an alternate drift within (TBD-253) hours.

[F 1.1.4]

1.2.1.11 The system shall limit the induced loads from normal operations (i.e., handling loads including shock, vibration, and acceleration) to the disposal container to less than the values identified in the following table (TBD-252).

Table 2 Induced Loads

Handling Loads	**Maximum Load**
Vibration	TBD
Shock	TBD
Acceleration	TBD

[F 1.1.14]

1.2.1.12 The system shall include features to support recovery from off-normal and/or Design Basis Events.

[MGDS RD 3.3.L]

1.2.2 Safety Criteria

1.2.2.1 Nuclear Safety Criteria

1.2.2.1.1 The transport system design shall prevent an uncontrolled descent. The frequency of an uncontrolled descent by the transport system shall be shown by analysis to be less than 6 x 10^{-4}/yr (TBV-265).

[F 1.1.9, F 1.1.10, F 1.1.11]

1.2.2.1.2 The transporter speed shall be limited to 8 km/hr (TBV-252).

[F 1.1.9, F 1.1.10]

1.2.2.1.3 Reserved.

1.2.2.1.4 The transport system shall limit the impact to an onboard disposal container to the design limits of the disposal container under the following design basis event conditions (TBV-271).

a) collision with an unyielding surface.
b) failures in mechanical, control, or actuation systems.
c) impact by a credible missile.

[F 1.1.9, F 1.1.10]

1.2.2.1.5 The transport system shall prevent the disposal container from being ejected by the transport system under the design basis event conditions listed below. The predicted frequency of occurrence of each of these events shall be shown by analysis to be less than 2 x 10^{-4}/yr (TBV-268).

a) failures in mechanical systems.
b) failures in control systems.
c) failures in actuation systems.

[F 1.1.10]

1.2.2.1.6 The system design shall prevent exposure of the disposal container to a heat flux intensity greater than the design criteria for the disposal container, i.e. an exposure for more than 30 minutes (TBV-269) to a heat flux not less than that of a radiation environment of 800 degrees C (TBV-269) with an emissivity of at least 0.9 (TBV-269) and surface absorptivity of at least 0.8 (TBV-269).

[F 1.1.9, F 1.1.10, F 1.1.11]

1.2.2.1.7 Reserved.

1.2.2.1.8 The emplacement system shall prevent uncontrolled operations which exceed the disposal container design limits under the following design basis event conditions listed below. The predicted frequency of occurrence of each of these events shall be shown by analysis to be less than 1 x 10^{-4}/yr (TBV-270, TBV-272).

a) gripping, hoisting, lowering, or transporting the disposal container.
b) runaway gantry.
c) spurious raising or lowering of the disposal container.
d) vertical drops and end collisions 2 m drop (TBV-272).
e) horizontal drops and side collisions 2.4 m drop(TBV-272).
f) puncture hazards: Greater of 1.9 m drop onto a disposal container support or 2.4 m drop onto a pier (TBV-272).

[F 1.1.9, F 1.1.10, F 1.1.11]

1.2.2.1.9 Reserved.

1.2.2.1.10 Upon loss of all sources of electrical power, the waste transport system and the waste emplacement gantry system, in association with interfacing control, instrumentation, and communication systems, shall assure that all operations may be brought to a timely halt with the disposal container in a safe and sustainable position. The probability of failure shall be shown by analysis to be less than or equal to (TBD-269).

[F 1.1.9, F 1.1.10, F 1.1.11]

1.2.2.1.11 The design of the waste emplacement system and associated control systems shall incorporate provisions to limit the likelihood of common-cause failures and human errors to the extent necessary (TBD-320) in meeting functional and probabilistic requirements defined in 1.2.2.1.1 through 1.2.2.1.10.

[F 1.1.11]

1.2.2.1.12 Reserved.

1.2.2.1.13 The structures, systems, and components important to safety shall be designed to withstand a Design Basis Earthquake of Frequency Category 1 or Frequency Category 2, as appropriate to the seismic frequency classification assigned to a specific structure, system, and component. Both vibratory ground motion and fault displacement of the Design Basis Earthquakes must be considered, as appropriate. The Design Basis Earthquake Input parameters of the Design Basis Earthquakes are defined in Tables (3 through 9). (TBD-241, TBV-273)

[F 1.1.12]

Table 3. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Surface Environment – Surface Design Spectral Accelerations for Design Earthquake Derived for 5 – 10 Hz Frequency Range

Response Frequency (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
10	(TBD)	(TBD)	(TBD)	(TBD)
20	(TBD)	(TBD)	(TBD)	(TBD)
100	(TBD)	(TBD)	(TBD)	(TBD)

Table 4. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Surface Environment –Surface Design Spectral Accelerations for Design Earthquake Derived for 1 – 2 Hz Frequency Range

Response Frequency (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
5	(TBD)	(TBD)	(TBD)	(TBD)
10	(TBD)	(TBD)	(TBD)	(TBD)
100	(TBD)	(TBD)	(TBD)	(TBD)

Table 5. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Surface Environment – Surface Design Peak Velocity (cm/sec) for Design Earthquake Derived for 5 – 10 Hz and 1 – 2 Hz Frequency Ranges

Design Earthquake Frequency Range (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
5 – 10	(TBD)	(TBD)	(TBD)	(TBD)
1 – 2	(TBD)	(TBD)	(TBD)	(TBD)

Table 6. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Subsurface Environment – Repository Interface (Underground) Design Spectral Accelerations for Design Earthquake Scaled to 5 – 10 Hz Frequency Range

Response Frequency (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
10	0.242 g (TBV)	0.765 g (TBV)	0.182 g (TBV)	0.620 g (TBV)
100	0.123 g (TBV)	0.391 g (TBV)	0.083 g (TBV)	0.288 g (TBV)

Table 7. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Subsurface Environment – Repository Interface (Underground) Design Spectral Accelerations for Design Earthquake Scaled to 1 – 2 Hz Frequency Range

Response Frequency (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
5	0.183 g (TBV)	0.471 g (TBV)	0.115 g (TBV)	0.309 g (TBV)
100	0.0915 g (TBV)	0.231 g (TBV)	0.0591 g (TBV)	0.156 g (TBV)

Table 8. Parameters for the Vibratory Ground Motion Design Basis Earthquake – Subsurface Environment – Repository Interface (Underground) Design Peak Velocity (cm/sec) for Design Earthquake Scaled to 5 – 10 Hz and 1 – 2 Hz Frequency Ranges

Design Earthquake Frequency (Hz)	Horizontal Motion	Horizontal Motion	Vertical Motion	Vertical Motion
	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)	Frequency Category 1 (1,000 yr Recurrence)	Frequency Category 2 (10,000 yr Recurrence)
5 – 10	13.42(TBV)	33.63(TBV)	6.26(TBV)	17.10(TBV)
1 – 2	14.73(TBV)	41.84(TBV)	7.55(TBV)	22.38(TBV)

Table 9. Parameters for the Ground Displacement Design Basis Earthquake – To Be Applied as Appropriate to Both Surface and Subsurface Facilities

Ground Displacement Design Basis Earthquake	**Fault Displacement**	**Comment**
Frequency Category 1 (10,000 yr Recurrence)	Less than 1 cm (TBV)	Considered insignificant with respect to repository design
Frequency Category 2 (100,000 yr Recurrence)	Less than 1 cm (TBV)	Considered insignificant with respect to repository design except for block-bounding faults: Bow Ridge 12 cm (TBV) Solitario Canyon 30 cm (TBV)

1.2.2.1.14 The system shall provide shielding or other measures to restrict the levels of occupational exposure to radiation per *10CFR20 Part 1201* (TBV-259) to the most restrictive of the following limits;

(a) An annual limit which is the more limiting of either (1) the total effective dose equivalent of 5 rem (0.05 Sv); or (2) the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rem (0.5 Sv).

(b) Annual limits to the lens of the eye, to the skin, and to the extremities, which are:

(1) an eye dose equivalent of 15 rem (0.15 Sv), and

a shallow-dose equivalent of 50 rem (0.50 Sv) to the skin or to any extremity.

[F 1.1.8][MGDS RD 3.1.B, 3.1.C][10CFR60.111(a)]

1.2.2.2 Non-nuclear Safety Criteria

1.2.2.2.1 The system shall provide redundant methods (TBD-251) for monitoring all remote transport and emplacement operations (ie. disposal container position, emplacement condition status, etc...).

[F 1.1.6, F 1.1.10],

1.2.3 Environmental Criteria

1.2.3.1 The system shall be designed to operate during and after exposure to the Natural Environments at the MGDS surface as identified in the following table (TBD-240).

Table 10. Surface Natural Environments

Surface Environment	Range
Temperature	-15 to 47 degrees C
Maximum Daily Precipitation	5.0 inches maximum in 24-hour period
Humidity	TBD
Snowfall	Maximum daily snowfall of 10 inches. Maximum monthly snowfall of 17 inches Maximum annual snowfall of 31 inches
Wind Speeds	Maximum wind speeds at 10 meters above ground level at the north portal area. Less than 40 m/sec for the maximum one-minute wind speed and 53 m/sec for the maximum one-second gust wind speed
Lightning	TBD

[F 1.1.12]

1.2.3.2 The system shall be designed to operate during and after exposure to the Subsurface Environments identified in the following table (TBD-240).

Table 11. Subsurface Operating Environments

Subsurface Environment	Range
Temperature Main Accesses Emplacement Drifts	50 degrees C maximum
Humidity	TBD

[F 1.1.12]

1.2.4 System Interfacing Criteria

1.2.4.1 Reserved.

1.2.4.2 The system shall operate within the Subsurface Facility System radii shown in the following table (TBV-253).

Table 12. Radius/Turnouts

Location	Minimum Radius
North Ramp curvature	305 (TBV) m
Emplacement drift turnout curvature	20 (TBV) m

[F 1.1.15]

1.2.4.3 The system shall receive inputs from other MGDS Systems for operations and controls defined as (TBD-254).

[F 1.1.7][MGDS RD 3.1.C][10CFR60.131(i)]

1.2.4.4 The system shall provide output to other MGDS Systems requiring system status defined as (TBD-255).

[F 1.1.7][MGDS RD 3.1.C][10CFR60.131(i)]

1.2.4.5 The Subsurface Electrical Power System shall provide normal, standby, and emergency power to the Waste Emplacement System as defined in the following table (TBD-256).

Table 13. Power Requirements

System Power	Voltage Requirements	Maximum Load
Transport Locomotive	TBD	TBD
Disposal Container Transporter	TBD	TBD

Reusable Rail Car	TBD	TBD
Gantry Carrier	TBD	TBD
Emplacement Gantry	TBD	TBD

1.2.4.6 The system shall interface with the surface facilities defined by the physical envelopes of (TBD-257).

[F.1.1.7]

1.2.4.7 The system shall operate within the Ground Control System physical envelopes including clearance provisions for Subsurface Emplacement Transportation System equipment, ventilation equipment and drift access doors, and utilities as defined in the following table (TBV-253).

Table 14 Physical Envelopes

Drift Types	**Outline Dimensions for WES**
Main Drifts and Ramps	Equipment Height: 5.60 m (TBV) Equipment Width: 3.55 m (TBV)
Drift Turnouts	Equipment Height: 5.60 m (TBV) Equipment Width: 6.15 m (TBV)
Emplacement Drifts	Equipment Height: 3.72 m (TBV) Equipment Width: 3.51 m (TBV)

[F 1.1.15]

1.2.4.8 The system shall accommodate the 0.80 m (TBV-254) difference in elevation between the bottom of the turnout and the bottom of the emplacement drift.

[F 1.1.15]

1.2.4.9 The system shall accommodate the track gage of 1.44 m (56 ½ in.) (TBV-274) for both the Transporter and the Reusable Rail Car.

1.2.5 Operational Criteria

1.2.5.1 The system shall be designed to support the periodic testing and maintenance defined as (TBD-258).

[F 1.1.13]

1.2.5.2 The system shall remotely control all waste transportation and emplacement operations when the radiation exposure levels exceed (TBD-259).

[F 1.1.5][MGDS RD 3.1.C][10CFR60.131(a)(2)]

1.2.5.3 The inherent availability for the system shall be greater than 0.9485.
[MGDS RD 3.3.A]

1.2.6 Codes and Standards

1.2.6.1 The system shall comply with the applicable provisions of 29 CFR 1910, *Occupational Safety & Health Standards*.
[F 1.1.11][MGDS RD 3.1.E]

1.2.6.2 The system shall comply with the applicable provisions of the 29 CFR 1926, Safety and Health Regulations for Construction.
[F 1.1.11][MGDS RD 3.1.F]

1.2.6.3 The system shall comply with the applicable provisions of 10 CFR 20, Standards for Protection Against Radiation.
[F 1.1.8][MGDS RD 3.1.B]

1.2.6.4 The system designs shall be in accordance with NFPA 70.
[MGDS RD 3.1.G]

1.2.6.5 The system designs for lightning protection shall be in accordance with NFPA 780.
[MGDS RD 3.1.G]

1.2.6.6 Reserved.

1.2.6.7 The system designs for Fire Protection Practices shall be in accordance with NFPA 801.
[MGDS RD 3.1.G]

1.2.6.8.1 The system designs for Fire Protection designs and practices shall be in accordance with NFPA 1.
[MGDS RD 3.1.G]

1.2.6.9 The system radiation shielding materials shall be in accordance with ANS 6.4.2.
[MGDS RD 3.1.G]

1.3 SUBSYSTEM DESIGN CRITERIA

1.3.1 Emplacement Gantry

1.3.1.1 Reserved.

1.3.1.2 Redundant lifting systems shall be designed for not less than 3 times and 5 times the design lift weight without producing stresses in excess of the material yield strength and ultimate strength, respectively.

1.3.1.3 Non-redundant lifting systems shall be designed for not less than 6 times and 10 times the design lift weight without producing stresses in excess of the material yield strength and ultimate strength, respectively.

1.3.1.4 Construction of overhead and gantry cranes shall be in accordance with ASME NOG-1.

1.4 CONFORMANCE VERIFICATION

A conformance verification matrix for this system will be provided in a future revision.

2.0 DESIGN DESCRIPTION

A design description for this system will be provided in a future revision.

3.0 MAINTENANCE

A maintenance section for this system will be provided in a future revision.

4.0 OPERATIONS

An operations section for this system will be provided in a future revision.

APPENDIX A REFERENCES

This section provides a listing of references used in Volume I.

ANS 1985. ANS 6.4.2, *Specification for Radiation Shielding Materials.*

ASME 1995. NOG-1, *Rules for Construction of Overhead and Gantry Cranes.*

CRWMS M&O 1997. *Controlled Design Assumptions Document.* B00000000-01717-4600-00032, Rev. 04, ICN 3. Las Vegas, Nevada: Author.

CRWMS M&O 1997. QAP-2-0 Activity Evaluation, *SDD Development/Maintenance*. Las Vegas, Nevada: Author.

CRWMS M&O 1997. NLP-3-15, Rev 4, *System Description Documents.* Las Vegas, Nevada: Author.

CRWMS M&O 1998. NLP-3-33, Rev 1, *System Description Documents.* Las Vegas, Nevada: Author.

DOE 1997. *Quality Assurance Requirements and Description.* DOE/RW-0333P, Rev 7.

YMP 1998. *Mined Geologic Disposal System Requirements Document.* YMP/CM-0025, Rev. 3. Las Vegas, Nevada: Yucca Mountain Site Characterization Office.

YMP 1998. *Q-List.* YMP/90-55Q, Rev. 5. Las Vegas, Nevada: Yucca Mountain Site Characterization Office.

NFPA 1997. NFPA 1, *Fire Prevention Code.*

NFPA 1996. NFPA 70, *National Electric Code.*

NFPA 1992. NFPA 780, *Lightning Protection Code.*

NFPA 1995. NFPA 801, *Recommended Fire Protection Practice for Facilities Handling Radioactive Materials.*

10CFR20. Energy: *Standards for Protection Against Radiation*, January 1, 1994.

10CFR60, Energy: *Disposal of High-Level Radioactive Wastes in Geologic Repositories*, January 1, 1997.

29 CFR 1910, Labor:*Occupational Safety & Health Standards*

29 CFR 1926, Labor: *Safety and Health Regulations for Construction*

APPENDIX B ACRONYMS

This section provides a listing of acronyms used in Volume I of this document.

ANS	American Nuclear Society
ASME	American Society of Mechanical Engineers
BWR	Boiling Water Reactor
CFR	Code of Federal Regulations
CRWMS	Civilian Radioactive Waste Management System
CDA	Controlled Design Assumptions Document
DC	Disposal Container
DOE	Department of Energy
F	Function
M&O	Management and Operating Contractor
MGDS	Mined Geologic Disposal System
MGDS RD	Mined Geologic Disposal System Requirements Document
MTU	Metric Tons Uranium
NFPA	National Fire Protection Association
PWR	Pressurized Water Reactor
QA	Quality Assurance
SDD	System Description Document
SNF	Spent Nuclear Fuel
SSCs	Systems, Structures, and Components
Sv	Sievert
TBD	To Be Determined
TBV	To Be Verified
TEDE	Total effective dose equivalent
WES	Waste Emplacement System
WHB	Waste Handling Building
WP	Waste Package

Waste Emplacement System Description Document

BCA000000-01717-1705-00017 REV 00

Volume II

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5.0 SDD CRITERIA BASIS STATEMENTS AND REFERENCES

5.1 SDD CRITERIA BASIS STATEMENTS

This section presents the criteria basis statements for criteria in Section 1.2 and 1.3 of Volume I. Criteria that are based wholly or in part by the Compliance Program (see Section 6) are traced to MGDS RD requirement 3.1.G.

1.2.1.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is required to establish how long the Waste Emplacement System must be designed to operate. The analysis establishes the basis for the number of years the system should be designed to operate.

II. Criteria Performance Parameter Basis

SDD Criteria Analysis: Waste Emplacement System Operational Life (Revision 01)

1. Purpose

The purpose of this analysis is to identify the operational life requirement for the Waste Emplacement System.

2. Assumptions:

2.1 The Waste Emplacement System is not required to support retrieval operations as defined in Reference 4.1, section 3.2.H. (used in 3.2).

Rationale: The Waste Retrieval System will provide the capability to support retrieval operations as required by Reference 4.1, section 3.2.H. The Waste Emplacement System will emplace disposal containers, and provide limited capability to move the emplaced disposal containers within the emplacement drifts, or to another emplacement drift, or back to the Waste Handling Building during the operation period, if required.

2.2 *Waste Quantity, Mix and Throughput Study Report*, Appendix M1, Table M-0 (Ref. 4.2) identifies an extended delivery schedule which could extend the number of years of waste receipt from 24 to 32 years. It is assumed that if the extended delivery schedule is required, the waste handling systems (including the Waste Emplacement System) would be required to support this extended period (used in 3.2).

Rationale: The purpose of this assumption is to provide an upper bound for the maximum number of years the Waste Emplacement System will be expected to operate based on the waste receipt schedules. This bounds the current delivery schedule and potential operational delays.

2.3 It is assumed that changes in future waste receipt schedules will be bounded by the extended delivery schedule, plus 25% margin for uncertainty (used in 3.2).

Rationale: The purpose of this assumption is to define a margin for uncertainty in meeting the projected delivery schedules. The 25% margin will envelope potential schedule fluctuations of up to 8 years. This margin was based on engineering judgement, and includes time for test and checkout of the system prior to the receipt of waste.

2.4 Performance Confirmation program requirements will not require waste handling systems to operate beyond what is required to support waste emplacement operations. The Waste Retrieval System will support the waste retrieval and recovery operations post-emplacement if off-normal conditions are encountered.

Rationale: The purpose of this assumption is to clearly identify that Performance Confirmation recovery requirements are not expected to extend the minimum operational life requirements.

3. Criteria Analysis: Waste Emplacement System Operational Life

3.1 The delivery schedule provided in the MGDS RD (Reference 4.1) section 3.2.B identifies the required waste delivery schedule of 24 years from 2010 to 2033.

3.2 The minimum operational life for the Waste Emplacement System is established by considering the required waste receipt schedule, potential bounding schedules and schedule uncertainties (due to schedule delays, operational delays in disposal container loading, etc...). Utilizing the *Waste Quantity, Mix and Throughput Study Report* (Ref 4.2) and assumption (2.2), the waste delivery schedule can be as long as 32 years for the extended delivery schedule. This delivery schedule bounds the MGDS RD requirement of 24 years, identified in section 3.1 above. A bounding margin of 25% (assumption 2.3) of 32 years requires an addition of 8 years (includes time for operational test and checkout prior to waste receipt). This results in a total minimum operational life of;

Total Operational Life = 32 years (bounding emplacement period) + 8 years (schedule margin uncertainty, and test and checkout)
= 40 years

4. References

4.1 *Mined Geologic Disposal System Requirements Document.* YMP/CM-0025, Rev. 3. February 1998. Las Vegas, Nevada: U.S. Department of Energy, Civilian Radioactive Waste Management System Yucca Mountain Project.

4.2 CRWMS M&O 1997. *Waste Quantity, Mix and Throughput Study Report**. B00000000-01717-5705-00059 Rev 01. Las Vegas, Nevada

5. Conclusion

The use of unqualified input* in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria does not affect nuclear safety.

The Waste Emplacement System is required to have a minimum operational life of 40 years.

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1.2.1.2 Criteria Basis Statement

I. Criteria Need Basis

This criteria is required to establish the rate at which the Waste Emplacement System must receive and emplace loaded disposal containers. The analysis establishes the basis for the throughput rate that the system must satisfy.

II. Criteria Performance Parameter Basis

The analysis that bounds the throughput requirements for operations on disposal containers by the Waste Emplacement System **has not been completed**. The preliminary bounding requirements are taken from *Waste Quantity, Mix and Throughput Study Report*, (page 45) and *Controlled Design Assumptions Document* Key 003.

1.2.1.3 Criteria Basis Statement

I. Criteria Need Basis

This criteria is required to establish the bounds for equipment design regarding the maximum distance over which the Disposal Containers (DCs) must be transported by the

Waste Emplacement System by rail between the Waste Handling Building and the emplacement drift entrance.

II. Criteria Performance Parameter Basis

Criteria Analysis: Distance from WHB to Emplacement Drift (Revision 01)

1. Purpose

The purpose of this analysis is to identify the maximum distance the Waste Emplacement System must transport disposal containers(DCs) between the Waste Handling Building (WHB) on the surface and the entrance to the most distant emplacement drift.

2. Assumptions:

2.1 The maximum distance of the rail system, when measured from the DC transfer dock at the WHB to the entrance of the North Portal, is approximately 272 m. Used in Section 3.1.

Rationale: A grading plan for the North Portal Repository is part of a recent design analysis (Ref. 4.1, Figure 8). The actual length, when measured from the end of the WHB to the entrance of the North Portal, is approximately 272 m.

2.2 The maximum distance of the rail system, when measured from the entrance at the North Portal to the drift Turnout of the last emplacement drift, located off the West Main, is approximately 8,918 m. Used in Section 3.2.

Rationale: Geometry of Ramps and Mains was documented in a recent design analysis (Ref. 4.2, Table 7-2). The actual length, when measured from the North Ramp to the Turnout of the last usable emplacement drift, is approximately 8,918 m.

2.3 The maximum distance of the rail system, when measured from the start of a drift turnout to the entrance of an emplacement drift, is approximately 38.4 m. Used in section 3.3.

Rationale: The current layout of the repository uses a total of 115 active emplacement drifts for DC emplacement, an additional 3 drifts (cross block drifts) for ventilation, and 2 stand-by, normally empty emplacement drifts. The last of the drifts to be used for emplacement is drift number 120, a ventilation cross drift.

The length of the turnouts varies with the geometry of the repository and the drift position as numbered. This was documented in a recent design analysis (Ref. 4.2, Table 7-3). As shown in the table within Ref. 4.2, the length of the last turnout is 29.4 m, and the length of the longest turnout is 38.4 m, when measured from the West Main to the entrance of an emplacement drift.

3. Criteria Analysis: This section investigates the maximum distance between the point at which the system receives the loaded disposal container at the WHB and an emplacement drift entrance.

3.1 The maximum distance between the WHB and the entrance of the North Portal (Assumption 2.1) is 272 m. However, in order to allow for potential modifications to the present layout, a maximum distance of 500 m is selected to provide a conservative margin.

3.2 The maximum distance between the North Portal and the drift Turnout of the emplacement drift farthest from the North Portal (Assumption 2.2) is 8,918 m. However, in order to allow for potential modifications to the present layout, a maximum distance of 9,000 m is selected to provide a conservative margin.

3.3 The maximum distance from the start of the drift turnout to the entrance of the emplacement drift (Assumption 2.3) is 38.4 m. However, in order to allow for potential modifications to the present layout, a maximum distance of 50 m is selected to provide a conservative margin.

3.4 The maximum distance is the distance from the loading dock at WHB to the entrance of the last possible emplacement drift accessible from the West Main. This one-way distance is equal to the sum of three individual segments as listed above in sections 3.1, 3.2, and 3.3. These segments have been identified as follows:

- from WHB to North Portal:	500 m
- from North Portal to last Turnout:	9,000 m
- from Turnout to Drift Entrance:	50 m

Based on these dimensions, the maximum distance, when measured from the WHB to the end of the last emplacement drift, will not exceed 9,550 m. For all practicable purposes this dimension has been rounded up to 10,000 m, or 10 km. Since this distance is based on a one-way trip, the same distance applies to the return trip. Therefore, the total distance for the round trip will not exceed 20,000 m, or 20 km.

4. References

4.1 CRWMS/M&O, *Repository Surface Design Site Layout Analysis**, DI: BCB000000-01717-0200-00007, Rev.00

4.2 CRWMS/M&O, *Repository Subsurface Layout Configuration Analysis**, DI: BCA000000-01717-0200-00008, Rev. 00.

5.0 Conclusion

The Waste Emplacement System is required to transport disposal containers from the MGDS surface to an emplacement drift entrance for a maximum distance of 10 km.

However, in the event that the dimensions provided in the Criteria Analysis (section 3.) change or increase beyond the present maximum distance, this change would not invalidate the present concept of the Waste Emplacement System for transport or emplacement of disposal containers.

The use of unqualified input* in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria does not affect nuclear safety.

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1.2.1.4 Criteria Basis Statement

I. Criteria Need Basis

The criteria is required to establish the maximum MGDS grade the Waste Emplacement System must be designed to traverse while transporting disposal containers. The analysis below establishes the basis for the maximum grade.

II. Criteria Performance Parameter Basis

Criteria Analysis: Maximum Grades (Revision 01)

1. Purpose

The purpose of this analysis is to identify the maximum grades that the Waste Emplacement System (WES) must operate upon, while moving Disposal Containers (DCs) by rail from the MGDS surface to the point of emplacement inside the emplacement drifts.

2. Assumptions:

2.1 Grades of ramps to be traversed by the WES for transport of the DCs are 2.1486%, maximum.

Rationale: This assumption is based on the grades for the Exploratory Studies Facility (ESF) that have already been excavated and will be used by the WES to transport DCs. Therefore, the grade is 2.1486%, maximum. Ref. 4.1, used in Section 3.1

2.2 The grades of the mains to be traversed by the WES for transport of the DCs are 2.1486%, maximum.

Rationale: This assumption is based on the most current layout for the SS Repository. Therefore, the grade is 2.1486%, maximum. Ref. 4.2, used in Section 3.2

2.3 The grades in the emplacement drifts to be traveled by the WES for emplacement of the DCs are 0.5%, maximum.

Rationale: This assumption is based on the most current layout for the SS Repository. Therefore, the grade is 0.5%, maximum. Ref. 4.3, used in Section 3.3

2.4 Disposal Containers will be transported through North Portal and the North Ramp.

Rationale: This assumption is based on the most current layout for the SS Repository, Ref. 4.3 and Key Assumption 068, Ref. 4.4, used in Section 3.4

3. Criteria Analysis: MGDS Subsurface Grades

3.1 Grades in Ramps. Reference 4.1 identifies the design of the Exploratory Studies Facility (ESF) including details of the ESF grades (Assumption 2.1) from the surface to the Topopah Spring (TS) Main Drift via the TS North Ramp and the TS South Ramp. The grades are summarized as follows:

Location	Grade
Entrance to North Portal	+2.0000%
North Portal to TS Main Drift	-2.1486%
Entrance to South Portal	+2.00%
South Portal to TS Main Drift	-2.6189%
TS Main Drift	+2.6189%(max)

From the grade summary shown above, the maximum slope/grade is 2.6189%.

However, operation of the WES is planned only through the North Portal and North Ramp and not through the South Portal and South Ramp. Because the grade of the existing North Ramp is 2.1486%, rounding this grade to 2.5% provides a conservative margin for the maximum expected grade to be traversed by the WES. A limitation for the grade is an important factor in the sizing of the Transport Locomotives for the current waste emplacement concept. Thus, the grade for the rail based transportation system is limited to 2.5%, maximum.

3.2 Grades in Mains. Reference 4.2 identifies the slope of the current the East Main that has already been excavated at 1.3500%. Other sections of various Mains that remain to be excavated will have grades/slopes up to 2.1846%, Ref. 4.2. Therefore, rounding this grade to 2.5% provides a conservative margin for the maximum expected grade to be traversed by the WES.

3.3 Grades in Emplacement Drifts. Reference 4.3 identifies the grades/slope of all future Emplacement Drifts at +0.5%. Therefore, rounding this grade to 1.0% provides a conservative margin for the maximum expected grade to be traveled by the WES.

4. References

4.1 CRWMS M&O 1996, *Engineered Barrier System Layout Calculation**, BABEAD000-01717-0200-00003, Rev. 04

4.2 CRWMS M&O 1997, *Subsurface Repository Slopes**, BCAA00000-01717-0200-00007, Rev. 00

4.3 CRWMS M&O 1997, *Repository Subsurface Layout Configuration Analysis**, BCA000000-01717-0200-00008, Rev. 00

4.4 CRWMS M&O 1997, *Controlled Design Assumption Document**, B00000000-01717-4600-00032, Rev. 04, ICN 3

5. Conclusion

5.1 Grades for the North Ramp and Mains will not exceed 2.5%.

5.2 Grades in the Emplacement Drifts will not exceed 1.0%.

However, in the event that the grades/slopes provided in the above Criteria Analysis (section 3.) require a change or increase in excess of the present maximum grades/slopes, this change would not invalidate the present concept for Waste Emplacement System. But, it may require additional and/or larger transport locomotives to move the transporter through the ramps and drifts, and it may require larger drive units for the emplacement gantry in the emplacement drifts.

The use of unqualified input* in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria does not affect nuclear safety.

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1.2.1.5 Criteria Basis Statement

I. Criteria Need Basis

This criteria is required to establish the maximum distance over which the Waste Emplacement System must transport disposal containers within an emplacement drift.

II. Criteria Performance Parameter Basis

Criteria Analysis: Maximum Length of Emplacement Drift (Revision 01)

1. Purpose

The purpose of this analysis is to identify the maximum distance the Waste Emplacement System must transport disposal containers within the emplacement drifts during emplacement operations.

2. Assumptions:

2.1 The maximum distance of the rail system, when measured from the drift entrance to the end of the emplacement drift is approximately 592 m. Used in Section 3.1.

Rationale: The length for each emplacement drift was documented in a recent design analysis (Ref. 4.1, Attachment I, Table I-2). This length varies for each drift and the respective drift number. The actual length of the last usable emplacement drift (drift #120), when measured from the drift entrance to its end station, is approximately 501 m, and the usable length of the longest emplacement drift (drift #91) is 592 m.

3. Criteria Analysis: Distance disposal containers are moved by the Waste Emplacement System within emplacement drifts.

3.1 The longest distance for disposal container emplacement in an emplacement drift is approximately 592 m (Assumption 2.1). However, in order to allow for potential modifications to the present layout, a maximum distance of 700 m is selected to provide a conservative margin.

4. References

4.1 CRWMS/M&O, *Repository Subsurface Layout Configuration Analysis**, DI: BCA000000-01717-0200-00008, Rev. 00.

5. Conclusion

The Waste Emplacement System is required to transport disposal containers within an emplacement drift having a maximum drift length of 700 m.

However, in the event that the dimensions provided in the Criteria Analysis (section 3.) requires a change or increase beyond the present maximum distance, this change would not invalidate the present concept of the Waste Emplacement System for transport or emplacement of disposal containers.

The use of unqualified input* in this analysis was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria. Additionally, the bounding design criteria does not affect nuclear safety.

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1.2.1.6 Criteria Basis Statement

I. Criteria Need Basis

This criteria is required to establish the maximum number of disposal containers which must be emplaced within the subsurface emplacement drifts by the Waste Emplacement System.

II. Criteria Performance Parameter Basis

Criteria Analysis: Number of Disposal Containers Emplaced (Revision 01)

1. Purpose

The purpose of this analysis is to establish the maximum number of disposal containers to be emplaced by the Waste Emplacement System.

2. Assumptions:

2.1 The option used for loading HLW and DSNF canisters into disposal containers will be the "co-disposal" option. (used in section 3.1)

Rationale: The *Waste Quantity, Mix and Throughput Study Report*, Paragraph 5.4.2, Reference 4.1 identifies two loading options; a "co-disposal" and a "separate" option. The "co-disposal" option denotes disposal of most of the DSNF in a "5-Pack" HLW DC (1 DSNF canister in each HLW DC). In this option, certain DSNF waste (such as Naval SNF) are disposed of separately. The "separate" option denotes separate disposal of HLW (4 canisters in one DC) and DSNF. The co-disposal option is used as the reference option in Ref. 4.1, as that option offers a reduction in the total number of disposal containers by approximately 2,000 containers.

2.2 A total of 10,305 disposal containers will need to be emplaced. (used in section 3.1)

Rationale: The schedule shown in the *Waste Quantity, Mix and Throughput Study Report*, Table 5-9, Reference 4.1 identifies 7,759 disposal containers required for Canistered Spent Nuclear Fuel (CSNF). The same report (Ref 4.1, Table 5-6) also identifies a total of 2,546 disposal containers for HLW and DSNF. The total of 10,305 is determined by adding 7,759 and 2,546.

2.3 The disposal of Pu (plutonium) MOX SNF will not affect the number of commercial SNF DCs. The disposal of immobilized plutonium will require approximately 200 DCs in addition to those required for HLW/DSNF. (used in section 3.1)

Rationale: Reference 4.2 requires that the MGDS store additional waste as noted above.

3. Criteria Analysis: This section investigates the total number of disposal containers to be transported and emplaced by the Waste Emplacement System.

3.1 The total number of disposal containers to be emplaced by the Waste Emplacement System is 10,305 per Assumption 2.2. Approximately 200 HLW DCs are required to accommodate the disposal of immobilized plutonium per Assumption 2.3. Adding 10,305 and 200 provides 10,505 as the maximum number of disposal containers. Rounding 10,505 up to the nearest 1,000 disposal containers provides a conservative margin in the number of disposal containers to be emplaced by the Waste Emplacement System. The maximum number to be emplaced by the Waste Emplacement System is therefore 11,000 disposal containers.

4. References

4.1 CRWMS/M&O 1997, *Waste Quantity Mix and Throughput Study Report*, B00000000-01717-5705-00059, Rev. 01.*

4.2 DOE/RW 1998, Baseline Change Proposal BCP-00-98-0001, *Incorporate Plutonium Disposition Materials in CRWMS Technical Baseline*.

5. Conclusion

The Waste Emplacement System is required to transport and emplace a maximum of 11,000 disposal containers.

*The software models used to generate throughput data in Ref. 4.1 were not qualified. In Ref. 4.1, however, it is stated that Ref. 4.1 does provide input to repository design. The input used in this analysis based on Ref. 4.1 was necessary to establish bounds for design with adequate conservative margins, and hence does not disqualify the results of the analysis. Additionally, the bounding design criteria does not affect nuclear safety.

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1.2.1.7 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the physical characteristics of the disposal containers to be handled by the Waste Emplacement System. These characteristics include the bounding limits for disposal container length, diameter, weight, radiation levels, and heat output.

II. Criteria Performance Parameter Basis

The analysis that bounds the physical characteristics including length, diameter, and weight of the disposal containers **has not been completed**. The preliminary bounding requirements are taken from *Controlled Design Assumptions Document*, Assumption Identifiers EBDRD 3.7.1.J.1 and 3.7.1.J.2.

Criteria Basis Statement: Radiation Levels

Disposal container design shall reduce the dose rate at all external surfaces of a loaded and sealed disposal container to 317 rem/hr (TBV-248) or less. This criteria identifies the primary disposal container interface with the Waste Emplacement System and the DC Handling System.

This requirement is needed as an interface between the disposal container and the waste emplacement system to allow adequate waste package transporter shielding design for an acceptable dose rate at the external surfaces of the transporter (in support of 10CFR20 requirements). This requirement is not intended to yield disposal container design features that are added solely for the purpose of shielding (unshielded waste packages recommended in the "Waste Package Size Study Report"), but is intended to establish the expected maximum dose rate the waste emplacement system will be designed to reduce.

This criterion is supported by guidance contained in the "MGDS Compliance Package for Uncanistered SNF Disposal Container." For specific paragraph reference see Table 6-1. Excessive radiation dose rates and radiation shielding (discussed in the compliance package) are avoided in part by interfacing with the Waste Emplacement System, which will provide the additional shielding necessary to reduce the dose rate to acceptable levels.

II. Criteria Performance Parameter Basis

Parameter:
The 317 rem/hr is taken from the "Radiolysis/Shielding Analysis for 21 PWR Uncanistered Fuel Waste Package" design analysis. The non-shielded waste package is supported by "Controlled Design Assumptions Document" assumptions EBDRD 3.2.4.5 and Key 031.

Criteria Basis Statement: Disposal Container Heat Output

I. Criteria Need Basis

The division of systems between several disposal container systems and the Ex-Container Systems results in the need for a maximum heat load interface criteria for the waste package. This interface criteria will allow the designers of the Ex-Container Systems to design the emplacement drifts to the 200 C emplacement drift temperature criteria ("*Controlled Design Assumptions Document*" assumption DCSS 023).

This requirement contributes directly to the evaluation of thermal loads within the repository as an interface between disposal container design and the Ex-Container System design.

This requirement contributes to the limiting of the near ground surface temperature change (MGDS 3.2.F) by limiting the thermal output per waste package. The thermal output per waste package is a key element in the thermal loading of the repository (which is indirectly established through the areal mass loading MGDS RD requirement 3.2.I), which is the determining factor in how much the near ground surface temperature will rise after emplacement.

The mass loading of the repository required in the MGDS RD (3.2.I) is meant to dictate a 'hot repository.' The thermal output per waste package is an important factor in the overall thermal loading of the repository.

II. Criteria Performance Parameter Basis

The maximum thermal output limit is derived from the limit on individual fuel modules for specific disposal container designs. These limits are:

1500 Watts for the 12 PWR High Heat and 12 PWR South Texas (12x1500 watts = 18000 watts) or 18 kW.
850 Watts for the 21 PWR all options (21x850 watts = 17850 watts) or 17.85 kW.
400 Watts for the 44 BWR all options (44x400 watts = 17600 watts) or 17.6 kW
520 Watts for the 24 BWR (24x520 watts = 12480) or 12.48 kW.

This information is obtained directly from the "Determination of Waste Package Design Configuration" and the "Preliminary Design Basis for WP Thermal Analysis" design analyses.

Therefore the highest expected heat load for a Waste Package given the present design configuration is 18 kW.

1.2.1.8 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the accuracy required for the emplacement of disposal containers by the Waste Emplacement System. The accuracy requirements should specify the tolerance for emplacement along the emplacement drift lateral and longitudinal axes.

II. Criteria Performance Parameter Basis

The analysis that bounds the required accuracy for emplacement of the disposal containers within the emplacement drifts **has not been completed**.

1.2.1.9 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the bounding requirements for the quantity of disposal containers and the minimum rate for moving an emplaced disposal container from the emplacement drift to the Waste Handling Building.

II. Criteria Performance Parameter Basis

The analysis that bounds the required quantity and rate for moving emplaced disposal containers from the emplacement drift to the WHB **has not been completed**.

1.2.1.10 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the bounding requirements for the quantity of disposal containers and the minimum rate for moving an emplaced disposal container from the emplacement drift to another emplacement drift.

II. Criteria Performance Parameter Basis

The analysis that bounds the required quantity and rate for moving emplaced disposal containers from the emplacement drift to another emplacement drift **has not been completed**.

1.2.1.11 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the requirements for bounding the loads induced (i.e., handling loads including shock, vibration, and acceleration) to the disposal container.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.1.12 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the requirements for recovery from off-normal or Design Basis Events. This requirement is derived from *MGDS RD*, 3.3.L.

II. Criteria Performance Parameter Basis

N/A

1.2.2.1.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with preventing an uncontrolled descent of the Waste Emplacement System transporter down the North Ramp.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System,* draft TRW IOC from D.W. Gwyn, dated 3/2/98.

1.2.2.1.2 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with preventing transporter derailment on curves in the North Ramp.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.3 Reserved.

1.2.2.1.4 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with limiting the impact to an on-board disposal container.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*. This criteria is supported by the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.19g7, 6.19g9, 6.20g19 and 6.44g1).

1.2.2.1.5 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with preventing the disposal container from being ejected from the transporter.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.6 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with limiting the geometry and selection of materials for construction to prevent initiation of a fire in the transporter or locomotive.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.7 Reserved.

1.2.2.1.8 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with limiting uncontrolled operations by the Emplacement Gantry which would exceed the design bases of the disposal container.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.9 Reserved.

1.2.2.1.10 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with safe operation upon loss of electrical power.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.11 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with limiting the likelihood of common-cause failures and human errors. This criteria should be derived with regards to the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, item 6.67g4)

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Safety Criteria for SDD SS-17, Waste Emplacement System*.

1.2.2.1.12 Reserved.

1.2.2.1.13 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the safety requirements associated with system operations during occurrence of a Design Basis Earthquake. The structures, systems, and components important to safety shall be in accordance with guidance provided in, *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain*, Topical Report YMP/TR-003-NP, Revision 2, (which adapts applicable portions of NUREG-0800 including sections 3.7.1, 3.7.2, 3.7.2, and 3.7.10) and future revisions to the Topical Report. The need for the criteria additional guidance can be applied from other Regulatory Documents and National Codes and Standards. This criteria is also derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6. 20g17 and 6.33g1)

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *Supplemental Seismic Criteria for SDDs*.

1.2.2.1.14 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the shielding or other measures required to reduce the levels of radiation for occupational exposure.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary bounding requirements are taken from *10CFR20 Part 1201, Code of Federal Regulations Standards for Protection Against Radiation.*

1.2.2.2.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to bound the number of methods and performance requirements for monitoring the disposal container position for all remote transport and emplacement operations.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.3.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the shielding or other measures required to bound the environments in which the Waste Emplacement System must operate. These environments should include temperature, humidity, maximum precipitation, maximum snowfall, maximum winds, and lightning.

II. Criteria Performance Parameter Basis

Criteria Analysis: Temperature Extremes (Revision 01)

1.0 Purpose

The purpose of this analysis is to determine the extreme outdoor temperatures at the repository site to support the establishment of design criteria. A separate analysis addresses the temperature and humidity conditions in terms of the parameters recommended for the design of repository heating, ventilation, and air conditioning systems.

2.0 Assumptions

2.1 The proposed repository waste handling and administrative surface facilities will be located adjacent to the north portal based on assumption Key 047 in the Controlled Design Assumptions Document (Reference 4.5), and the air intake for the subsurface emplacement area ventilation system will be at the north portal area based on drawing BCA000000-01717-2700-86012 Subsurface Ventilation Emplacement and Development Schematic (Reference 4.6).

2.2 Of the nine meteorological monitoring sites operated by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD), Site 1 (NTS-60), which is the closest to the north portal, is assumed to be the most representative of environmental conditions to be experienced at facilities in the north portal area. Consideration of the observations and projections for other R/EFPD sites in an informed manner is useful in understanding the variability of climatological parameters and adding conservatism to estimates based on Site 1 information. Three additional sites that are nearby are assumed to be most representative in determining such variations in the general vicinity of the north portal if the impacts of topography, particularly with regard to airflows, are accounted for; these sites are: Site 3 (Coyote Wash), Site 4 (Alice Hill), and Site 7 (Sever Wash). [Notes: The locations and elevations of the nine R/EFPD sites are given on pages 2-2 and 2-3 of Reference 4.1. Descriptions of the sites and the expected uses of the data collected at the respective sites are provided on pages 1-1 to 1-5 of Reference 4.2.]

3.0 Criteria Analysis

Reference 4.1 (page 5-1) summarizes as follows: □Air temperatures in the region vary by 15°C on a diurnal (day and night) cycle during most of the year due to the prevailing clear skies and low atmospheric humidity. Daytime summer temperatures frequently exceed 35°C, but rarely do they exceed 45°C. Winter temperatures can reach 0°C during many nights, but -10°C is an unusually cold temperature.□ Additional insight is obtained by examination of the extreme temperature data for the nine R/EFPD sites from Appendix A of Reference 4.1, which are discussed below. Five of the nine R/EFPD sites had an observed temperature as low as -12°C, and all but one site had an observed temperature of approximately -10°C or colder. All of the sites had an observed temperature of approximately 40°C or hotter, but only one site had an observed temperature as high as 45°C. In summary, the extreme temperatures measured at the nine R/EFPD sites range from -13.1°C to 45.1°C. The extreme temperatures observed over longer periods at other stations in the area extend the bounds of the possible temperature range no more than two degrees in each direction.

Monthly and annual climatological summaries for the nine R/EFPD sites are provided in Tables A-1 through A-9 of Reference 4.1. The collected data included 11 years of temperature data at Sites 1-5 and four years of temperature data at Sites 6-9. These tables show the monthly values for each of the twelve months, and the annual values, for each of the following temperature statistics: extreme maximum, mean maximum, mean, mean minimum, and extreme minimum. These temperature statistics are summarized in the first column of data in Table 1 below for R/EFPD Site 1. Two values are shown for both the mean maximum and the mean minimum: one value is the mean maximum (minimum) for the hottest (coldest) month, and the other is the overall annual mean maximum (minimum).

Table 1. Temperature Statistics for R/EFPD Sites and Selected Other Stations (°C)

Temperature Statistic	Site 1	Sites 3, 4, & 7	Sites 2, 5, 6, 8, & 9	Desert Rock	Las Vegas
Extreme maximum	40.9	40.4 / 42.8	39.9 / 45.1	44.4	46.7
Mean maximum (hottest month)	34.2	28.0 / 36.9	32.3 / 39.5	36.9	40.1
Mean maximum (annual)	22.0	20.9 / 24.0	19.8 / 25.9	24.6	26.6
Mean	16.8	15.8 / 16.7	15.1 / 18.2	NA	NA
Mean minimum (annual)	11.5	6.6 / 11.8	7.9 / 12.0	10.2	12.0
Mean minimum (coldest month)	2.1	-2.4 / +2.6	-0.7 / +2.9	-0.2	0.9
Extreme minimum	-11.7	-12.8 / -12.2	-13.1 / -7.7	-14.4	-13.3
Median of annual max.	39	38 / 41	36 / 44	NA	NA
Median of annual min.	-6	-6 / -10	-6 / -9	NA	NA

Another form of climatological summary commonly used in design of heating, ventilation, and air conditioning (HVAC) systems is that recommended by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), which is provided in Table A-17 of Reference 4.1. The summary includes the median of annual maximum temperatures and the median of annual minimum temperatures for each of the nine R/EFPD sites. These measures are summarized at the bottom of Table 1.

The second column of data in Table 1 shows the range of each of the temperature statistics for Sites 3, 4, and 7. The two values shown in each cell are the lowest and highest of the three values for these sites. The highest maximums and the lowest minimums are all from Site 7. The next column in Table 1 shows the range of the same statistics for R/EFPD Sites 2, 5, 6, 8, and 9. Only the lowest and highest of the five values are shown in this column.

Tables A-11 through A-14 of Reference 4.1 provide four of the temperature statistics (excluding the mean) for other Nevada locations. The temperature statistics for Desert Rock and Las Vegas are summarized in Table 1.

Estimates of the mean, mean maximum, and mean minimum temperatures for the north portal area are best represented by the values for Site 1, as given in Table 1. Other sites are also considered in conservatively estimating temperature extremes. Consideration of the closer sites 3, 4, and 7 suggests that the minimum might be lower and the maximum might be higher than observations at Site 1. Consideration of the other R/EFPD sites would further extend the bounding minimum and maximum temperatures. Since Desert Rock reflects a somewhat lower minimum and Las Vegas reflects a higher maximum, additional expansion of the extreme temperature limits by a small margin is suggested to ensure more conservative estimates. Rounding the minimum down and the maximum up, the bounding extreme temperatures are -15°C and 47°C, representing the worse case design extremes for the Repository. Reference 4.1 (page 4-13) indicates that the extreme maximum and minimum temperatures at the stations at Amargosa Farms and Beatty are within these extremes.

4.0 References

4.1 *Engineering Design Climatology and Regional Meteorological Conditions Report.* B00000000-01717-5707-00066 REV 00. CRWMS M&O. October 2, 1997.

4.2 *Meteorological Monitoring Program, 1996 Summary Report.* B00000000-01717-5705-00072 REV 00. CRWMS M&O. October 28, 1997.

4.3 *Controlled Design Assumptions Document.* B00000000-01717-4600-00032 REV 04, ICN 3. CRWMS M&O. November, 1997.*

4.4 *Subsurface Ventilation Emplacement and Development Schematic.* BCA000000-01717-27000-86012. CRWMS M&O.

5.0 Conclusion

*The use of unqualified input in the analysis (in assumption 2.1) was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria.

Outside temperatures at the repository site will be within the range of -15°C to 47°C.

Preparer: W.L. Clem (signature on file) Date: 3/30/98

Co-Preparer: K.M. Kersch (signature on file) Date: 3/30/98

Checker: G.M. Teraoka (signature on file) Date: 3/30/98

Criteria Analysis: Maximum Daily Precipitation (Revision 01)

1.0 Purpose

The purpose of this analysis is to determine the maximum daily precipitation at the repository site to support the establishment of design criteria.

2.0 Assumptions

2.1 The proposed repository waste handling and administrative surface facilities will be located adjacent to the north portal based on assumption Key 047 in the Controlled Design Assumptions Document (Reference 4.5), and the air intake for the subsurface emplacement area ventilation system will be at the north portal area based on drawing BCA000000-01717-2700-86012 Subsurface Ventilation Emplacement and Development Schematic (Reference 4.6).

2.2 Of the nine meteorological monitoring sites operated by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD), Site 1 (NTS-60), which is the closest to the north portal, is assumed to be the most representative of environmental conditions to be experienced at facilities in the north portal area. Consideration of the observations and projections for other R/EFPD sites in an informed manner is useful in understanding the variability of climatological parameters and adding conservatism to estimates based on Site 1 information. Three additional sites that are nearby are assumed to be most representative in determining such variations in the general vicinity of the north portal if the impacts of topography, particularly with regard to airflows, are accounted for; these sites are: Site 3 (Coyote Wash), Site 4 (Alice Hill), and Site 7 (Sever Wash).

[Notes: The locations and elevations of the nine R/EFPD sites are given on pages 2-2 and 2-3 of Reference 4.1. Descriptions of the sites and the expected uses of the data collected at the respective sites are provided on pages 1-1 to 1-5 of Reference 4.2.]

3.0 Criteria Analysis

3.1 Extreme Projections based on Monitoring in the Area

Maximum daily precipitation projections are provided by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD) for its nine meteorological monitoring sites and for other stations in the southern Nevada region with more lengthy periods of data collection. The projections were developed using established extreme-value statistical tools in analyzing the distribution of observed values at each site. The extreme daily precipitation projections for each site for 50-year, 100-year, and 200-year return periods are presented in Table 4-3 of Reference 4.1.

Site 1 (NTS-60), which is the site closest and most representative of the north portal location, yielded the highest daily precipitation projections (2.68, 3.03, and 3.40 inches, respectively) for 50-year, 100-year and 200-year return periods. In addition, nearby Site 4 (Alice Hill) had the second highest projections (2.61, 2.92, and 3.25 inches, respectively). Site 1 is the only one of the R/EFPD sites with 10 years of record. Reference 4.1 (page 4-19) indicates that sites with shorter periods of record, less than 10 years, tend to have lower estimated maximums because the maximum observed storms in the area occurred prior to these sites beginning operations. For comparison, the 100-year return-period projections of maximum daily precipitation for other locations in the area with over 20 years of data ranged from 2.21 to 3.52 inches. The 4JA site, which compares closely with R/EFPD sites 3, 4, and 7 on the basis of total annual precipitation, yielded a 100-year return-period projection of 3.23 inches for the maximum daily precipitation. For further comparison, the 1973 NOAA Atlas 2 provides a 100-year return-period estimate of 2.60 inches for a 24-hour rainfall (Reference 4.3, as documented in Reference 4.1, page 4-19).

The 100-year return period projections discussed above for R/EFPD and other nearby sites indicate that the maximum daily rainfall should not exceed 3 to 3.5 inches. However, the range of conditions represented in the observed precipitation data leaves room for some uncertainty in the tail of the distribution fitted to the data. Hence, Reference 4.1 adds conservatism through additional margin to conclude that the maximum daily precipitation would not exceed 5.0 inches, as indicated in Section 5.0 below

3.2 Consideration of Other Information

Reference 4.1 (page 4-20) notes that summer thunderstorms are capable of producing extremely heavy local precipitation that is not necessarily recorded at an official weather station. Examples of unofficially reported isolated rainfalls were cited.

The precipitation analyses in Reference 4.1, as discussed above, are focused on southern Nevada, the location of Yucca Mountain. The report also cites other precipitation studies that utilized data from stations in California, Utah, and Arizona. For example, a National Weather Service 1977 report (Reference 4.4) is discussed in Reference 4.1, page 4-21, but its results, which were based on precipitation events that occurred in different climatic regime hundreds of kilometers away, were indicated to be too conservative for estimating possible rainfall at the Yucca Mountain site.

4.0 References

4.1 *Engineering Design Climatology and Regional Meteorological Conditions Report*. B00000000-01717-5707-00066 REV 00. CRWMS M&O. October 2, 1997.

4.2 *Meteorological Monitoring Program, 1996 Summary Report*. B00000000-01717-5705-00072 REV 00. CRWMS M&O. October 28, 1997.

4.3 *Precipitation-Frequency Atlas of the Western United States*, Volume VII-Nevada. J.F. Miller, R.H. Frederick, and R.J. Tracey. National Oceanic and Atmospheric Administration (NOAA), U.S. Dept. of Commerce, Silver Springs, Maryland. 1973. (Not used as input; only cited for comparison.)

4.4 *Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages*. Hydrometerological Report No. 49. National Weather Service. Prepared for U.S. Dept. of Commerce, NOAA and the U.S. Dept. of Army, Corps of Engineers. September 1977. (Not used as input; only cited for comparison.)

4.5 *Controlled Design Assumptions Document*. B00000000-01717-4600-00032 REV 04, ICN 3. CRWMS M&O. November, 1997.*

4.6 *Subsurface Ventilation Emplacement and Development Schematic*. BCA000000-01717-27000-86012. CRWMS M&O.

5.0 Conclusion

*The use of unqualified input in the analysis (in assumption 2.1) was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria.

It is estimated that the maximum daily precipitation at the repository site will not exceed 5.0 inches. This is consistent with the relevant conclusion presented in Reference 4.1 (page 4-21) that the statistical analyses of observed and estimated precipitation data performed for that report □indicate that the maximum daily precipitation within 50 km of Yucca Mountain is not expected to exceed five inches.□ Five inches represents a conservative estimate of the maximum daily precipitation that includes a substantial margin above the approximate 3 to 3.5-inch extreme projections resulting from statistical analysis of data from stations in the area.

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Checker:	G.M. Teraoka	(signature on file)	Date:	3/30/98

Criteria Analysis: Surface Humidity

The analysis that bounds the surface humidity **has not been completed**.

Criteria Analysis: Maximum Snowfall (Revision 01)

1.0 Purpose

The purpose of this analysis is to determine the maximum snowfall at the repository site to support the establishment of design criteria.

2.0 Assumptions

None

3.0 Criteria Analysis

The nine meteorological monitoring sites operated by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD), as defined in Reference 4.1 pages 1-1 to 1-5, do not monitor snowfall because it is an infrequent occurrence. Reference 4.2 includes snowfall information for some other sites in the general area that were examined to bound the maximum snowfall that could occur at the repository. The closest of these sites is Desert Rock Airport south of Mercury, about 45 km east-southeast of Yucca Mountain. Snowfall data were also included for Tonopah, which is about 150 km north-northwest of the repository and at a higher elevation. Tables A-12 and A-14 of Reference 4.2 provide climatological summaries for these locations that include maximum daily, monthly, and annual snowfall measures. The snowfall data for Tonopah is considered to provide a conservative estimate of snowfall at the repository site for the following reasons: The elevation at R/EFPD Site 1 (which is closest to the proposed repository surface facilities) is 3750 ft, Desert Rock is 3300 ft, and Tonopah is 5430 ft (altitudes are listed in ref 4.3 in meters). While Desert Rock is closer to Yucca Mountain, it is at a lower altitude. Average yearly total precipitation for Site 1, Desert Rock and Tonopah are 4.97, 5.5, and 5.53 inches respectively (Reference 4.2, Tables A-1, A-12 and A-14). Annual average snow depths are 2.86 inches at Desert Rock and 13.53 inches at Tonopah. Tonopah is further north, receives slightly more total precipitation and is at a higher altitude, therefore use of snow data from Tonopah is considered to be a conservative surrogate for Yucca Mountain.

The snowfall data for Tonopah were not collected under an OCRWM approved QA program. The data were collected by the National Weather Service at its Tonopah station and are accepted by the scientific community as an accurate measure of the actual snowfall at the station. The data are suitable for use in the analysis, as discussed above, to provide conservative estimates of the possible maximum snowfall at the repository site for use in design criteria.

4.0 References

4.1 *Meteorological Monitoring Program, 1996 Summary Report.* B00000000-01717-5705-00072 REV 00. CRWMS M&O. October 28, 1997.

4.2 *Engineering Design Climatology and Regional Meteorological Conditions Report.* B00000000-01717-5707-00066 REV 00. CRWMS M&O. October 2, 1997.

4.3 *Regional and Local Wind Patterns Near Yucca Mountain.* B00000000-01717-5705-00081 REV 00. CRWMS M&O. November 20, 1997.

5.0 Conclusion

It is estimated that the maximum snowfall at the repository site will not exceed the values given below.

5.1 Maximum daily snowfall will not exceed 10 inches

5.2 Maximum monthly snowfall will not exceed 17 inches

5.3 Maximum annual snowfall will not exceed 31 inches

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Checker: G.M. Teraoka ___(signature on file)_______________ Date: __3/30/98___

Criteria Analysis: Maximum Wind Speed (Revision 01)

1.0 Purpose

The purpose of this analysis is to determine the maximum wind speed at the repository site to support the establishment of design criteria.

2.0 Assumptions

2.1 The proposed repository waste handling and administrative surface facilities will be located adjacent to the north portal based on assumption Key 047 in the Controlled Design Assumptions Document (Reference 4.3), and the air intake for the subsurface emplacement area ventilation system will be at the north portal area based on drawing BCA000000-01717-2700-86012 Subsurface Ventilation Emplacement and Development Schematic (Reference 4.4).

2.2 Of the nine meteorological monitoring sites operated by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD), Site 1 (NTS-60), which is the closest to the north portal, is assumed to be the most representative of environmental conditions to be experienced at facilities in the north portal area. Consideration of the observations and projections for other R/EFPD sites in an informed manner is useful in understanding the variability of climatological parameters and adding conservatism to estimates based on Site 1 information. Three additional sites that are nearby are assumed to be most representative in determining such variations in the general vicinity of the north portal if the impacts of topography, particularly with regard to airflows, are accounted for; these sites are: Site 3 (Coyote Wash), Site 4 (Alice Hill), and Site 7 (Sever Wash). [Notes: The locations and elevations of the nine R/EFPD sites are given on pages 2-2 and 2-3 of Reference 4.1. Descriptions of the sites and the expected uses of the data collected at the respective sites are provided on pages 1-1 to 1-5 of Reference 4.2.]

3.0 Criteria Analysis

Maximum one-minute wind speed and one-second gust wind speed projections are provided by the CRWMS M&O Radiological and Environmental Field Programs Department (R/EFPD) for its nine meteorological monitoring sites. The projections were developed using established extreme-value statistical tools in analyzing the distribution of observed values at each site.

The projections of maximum <u>one-minute</u> wind speeds for each site for 50-year, 100-year, and 200-year return periods are presented in Table 4-4 of Reference 4.1 (page 4-22) along with the maximum recorded values at the respective sites. Projections at Site 1 are provided based on only one year of data but with observations at both 10 meters and 60 meters above ground level (m-agl). See the upper rows in Table 1 below.

Maximum one-minute wind speed projections for other sites are based on observations at 10-meter towers and three years of data. The winds at sites with 10-meter towers in valley locations reflect influence of nearby terrain, while data from the 60-meter tower at Site 1 and the two sites on top of terrain features (Sites 2 and 4) show influence of larger scale down slope motion from higher terrain north and east of Midway Valley (Reference 4.1, page 4-13). The one-minute projections for the 60-meter above ground level at Site 1 are nearly the same as the projections for Site 2, the ridge top site on Yucca Mountain. The highest one-minute wind speed estimate from the R/EFPD stations is for Site 4 on top of Alice Hill. In contrast, the lowest one-minute wind speed estimate is for the sheltered location at Site 3 in Coyote Wash. See projections for sites 3 and 4 in Table 1.

Table 1. Projected and Observed Maximum Wind Speeds at Selected R/EFPD Sites

Parameter and Location	**Projections (m/sec)**			**Maximum recorded (m/sec)**	**Years Covered**
	50-year return period	**100-year return period**	**200-year return period**		
Max. 1-minute wind speed					
Site 1 (10 m-agl)	32.78	34.57	36.35	23.26	1996
Site 1 (60 m-agl)	42.01	44.36	46.72	27.89	1996
Site 3 (10 m-agl)	25.42	26.78	28.13	18.60	1994-1996
Site 4 (10 m-agl)	45.93	48.47	51.00	33.16	1994-1996
Max. 1-second gust wind speed					
Site 1 (10 m-agl)	45.00	47.46	49.93	28.29	1996
Site 1 (60 m-agl)	50.97	53.78	56.60	34.34	1996
Site 3 (10 m-agl)	41.02	43.28	45.53	28.37	1993-1996
Site 4 (10 m-agl)	54.11	57.01	59.91	40.22	1993-1996

The projections of maximum <u>one-second gust</u> wind speeds for each site for 50-year, 100-year, and 200-year return periods are presented in Table 4-6 of Reference 4.1 (page 4-25) along with the maximum recorded values at the respective sites. See the data for Sites 1, 3, and 4 at bottom of Table 1. Projections at Site 1 are again based on only one year of data but with observations at both 10 meters and 60 meters above ground level (m-agl). The projections of maximum one-second gust wind speeds for other sites are based on observations at 10-meter towers and four years of data.

The ratio of the projections at 10 m-agl to projections at 60 m-agl is 0.88 for the maximum <u>one-second gust</u> wind speed projections for Site 1 (for each of the return periods). In comparison, a lower ratio of 0.78 is obtained between the 10 and 60 m-agl projections for the maximum <u>one-minute</u> wind speed (for each of the return periods).

The Site 4 maximum one-minute and one-second wind speed estimates provide the most conservative projections from the R/EFPD sites. Since this is an exposed site on the top of Alice Hill, these projections are considered more representative of the 60 m-agl at Site 1 and the north portal area. The Site 4 projections for the 200-year return period are rounded and used as the estimates at 60 m-agl: (51 m/sec and 60 m/sec). Estimates at 10 m-agl are factored from the estimates at 60 m-agl based on the ratios of Site 1 projections at 10 and 60 m-agl noted above: (51 x 0.78 = 40 m/sec; 60 x 0.88 = 53 m/sec). The 200-year return-period projections were used to provide more conservative estimates than the 100-year return-period.

4.0 References

4.1 *Engineering Design Climatology and Regional Meteorological Conditions Report*. B00000000-01717-5707-00066 REV 00. CRWMS M&O. October 2, 1997.

4.2 *Meteorological Monitoring Program, 1996 Summary Report*. B00000000-01717-5705-00072 REV 00. CRWMS M&O. October 28, 1997.

4.3 *Controlled Design Assumptions Document*. B00000000-01717-4600-00032 REV 04, ICN 3. CRWMS M&O. November, 1997.*

4.4 *Subsurface Ventilation Emplacement and Development Schematic*. BCA000000-01717-27000-86012. CRWMS M&O.

5.0 Conclusion

*The use of unqualified input in the analysis (in assumption 2.1) was necessary to establish the bounding characteristics for the design criteria. The inclusion of this input does not disqualify the results of the analysis due to the conservative margin used in establishing the bounding design criteria.

It is estimated that the maximum wind speeds at 60 meters above ground level at the north portal area will not exceed 51 m/sec for maximum one-minute wind speed and 60 m/sec for maximum one-second gust wind speed. It is estimated that the maximum wind speeds at 10 meters above ground level at the north portal area will not exceed 40 m/sec for the maximum one-minute wind speed and 53 m/sec for the maximum one-second gust wind speed.

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Co-Preparer: K.M. Kersch (signature on file) Date: 3/30/98

Checker: G.M. Teraoka (signature on file) Date: 3/30/98

Criteria Analysis: Surface Lightning

The analysis that bounds this requirement **has not been completed**.

1.2.3.2 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the subsurface environmental conditions in which the Waste Emplacement System must operate. These environments include temperature and humidity. The analysis should take into account the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items, 6.10g3)

II. Criteria Performance Parameter Basis

The analysis that bounds these requirements **has not been completed for humidity**.

Criteria Analysis: Maximum Ambient Temperature in Remote Access Areas (Revision 01)

1.0 PURPOSE

To establish the maximum dry bulb temperature as threshold limit for repository environment that will allow commercial grade equipment to operate in remote repository access areas. This will include drift temperature for remote control operation of equipment during loading and unloading of waste packages in emplacement drift.

2.0 ASSUMPTIONS

Remote operated vehicles and equipment are using commercially available on-board electronics and actuators. It is good engineering practice to use commercial grade electronic units to take advantage of common technology and cost effective components.

3.0 CRITERIA ANALYSIS

3.1 Design strategies and existing technologies are available to use remote operated vehicles within elevated thermal environments expected inside emplacement drifts. Appropriate components (motors, gears, bearings, etc) and structural materials that are suitable for use at elevated temperatures are common industry practices. A key area of concern, however, is the use of on-board electronics and actuators which are sensitive to temperature ranges expected. Typically commercial grade electronics and components have maximum operating temperatures in the range of 50 to 85 °C (122 to 185 °F) (Reference 4.0). There are also available technology specialized for operating electronic components in high temperature environment over 85 °C in the aerospace, automotive, and oil & gas industries. This specialized equipment will be costly to operate in the repository and is not recommended.

3.2 Except for special high temperature equipment used in performance confirmation data acquisition system, the elevated temperature limit for remote controlled access areas will be conservative in that the lower limit in Reference 4.0 is used for repository operations. The temperature limit should allow a wide range use of commercially available cost effective electronics and components. The repository design should be able to maintain a maximum recommended dry-bulb temperature of 50 °C (122 °F) for remote access drift.

4.0 REFERENCE

Dorf, R.C., 1993, *The Electrical Engineering Handbook,* CRC Press, ISBN 0-8493-0185-8

5.0 CONCLUSION

The maximum ambient dry-bulb temperature for remote operation of repository equipment and electronic components is 50 °C (122 °F). The subsurface ventilation shall have capability to provide ambient air below this maximum limit to allow commercial grade equipment to operate in repository remote access areas.

Preparer: _(signature on file)____Date _3/30/98_
Romeo S. Jurani

Checker: _(signature on file)____Date _3/30/98__
Norman Bartley

1.2.4.1 Criteria Basis Statement

Reserved.

1.2.4.2 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for bounding the North Ramp curvature and the Emplacement drift turnout curvature. This criteria is needed for use in selection of the transport locomotives.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.
The current values were estimated from the current subsurface facility layout drawings within the *Repository Subsurface Layout Configuration Analysis*.

1.2.4.3 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for bounding the signal inputs from other MGDS Systems for controlling/monitoring the Waste Emplacement System.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.4.4 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for bounding the signal outputs from the Waste Emplacement System to other MGDS Systems for controlling/monitoring the Waste Emplacement System.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.4.5 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for the electrical interfaces to the subsurface electrical power system.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.4.6 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for bounding the physical envelopes of the Waste Handling Building for the interface with the Waste Emplacement System.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.4.7 Criteria Basis Statement

I. Criteria Need Basis
This criteria is needed to establish the requirements for bounding the physical envelopes within the Main Drifts and Ramps, Drift Turnouts, and Emplacement Drifts.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

The preliminary data is summarized below as taken from the noted drawings;

Main Drifts and Ramps:

3.58 m (Gantry height)	(from drawing BCAF00000-01717-2700-85007, Rev 00)
+ 1.22 m (Gantry Carrier height)	(from drawing BCAF00000-01717-2700-85004, Rev 00)
+ .17 m (rail height)	(from analysis BCA000000-01717-0200-00012, Rev 00)
+ .63 m (additional clearance)	(from drawing BCAC00000-01717-0200-00062, Rev 00)
5.60 m = total height	

Main Drifts and Ramps (continued):
3.55 m (Gantry Carrier width) (from drawing BCAF00000-01717-2700-85004, Rev 00)

Drift Turnouts:
5.60 m (Gantry+Carrier+rail+clearance) (from Main Drifts and Ramps height references above)
6.15 m (Transporter width) (from drawing BCAF00000-01717-2700-85001, Rev 00)

Emplacement Drifts:
3.58 m (Emplacement Gantry height) (from drawing BCAF00000-01717-2700-85007, Rev 00)
+ .14 m (rail height) (from analysis BCA000000-01717-0200-00012, Rev 00)
3.72 m = total height

3.51 m (Emplacement Gantry width) (from drawing BCAF00000-01717-2700-85007, Rev 00)

1.2.4.8 Criteria Basis Statement

This criteria is needed to establish the requirements for bounding the physical envelope available due to the height difference between the drift turnout excavation and the emplacement drift excavation.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary data was taken from *Preliminary Waste Package Transport and Emplacement Equipment Design*.

1.2.4.9 Criteria Basis Statement

This criteria is needed to establish the interfacing rail gage.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**. The preliminary data was taken from *Preliminary Waste Package Transport and Emplacement Equipment Design*.

1.2.5.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the requirements for periodic testing and maintenance of the Waste Emplacement System.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.5.2 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the radiation exposure levels which would require that waste transportation and emplacement by the Waste Emplacement System be operated remotely.

II. Criteria Performance Parameter Basis

The analysis that bounds this requirement **has not been completed**.

1.2.5.3 Criteria Basis Statement

I. Criteria Need Basis

This criteria is needed to establish the availability of the waste emplacement system.

II. Criteria Performance Parameter Basis

The analysis that bounds this criteria is in the *Bounded Minimum Inherent Availability Requirements for the System Description Documents*, dated March 1998, DI#B0000000-01717-0200-00147, Rev 0.

1.2.6.1 Criteria Basis Statement

I. Criteria Need Basis

This criteria is derived from the regulatory precedence cited in the *Mined Geologic Disposal System Requirements Document*, paragraph 3.1.E.

II. Criteria Performance Parameter Basis

N/A

1.2.6.2 Criteria Basis Statement

I. Criteria Need Basis

This criteria is derived from the regulatory precedence cited in the *Mined Geologic Disposal System Requirements Document*, paragraph 3.1.F.

II. Criteria Performance Parameter Basis

N/A

1.2.6.3 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the *Mined Geologic Disposal System Requirements Document*, paragraph 3.1.B.

II. Criteria Performance Parameter Basis

N/A

1.2.6.4 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.19g23, 6.20g15 and 7.65g1)

II. Criteria Performance Parameter Basis

N/A

1.2.6.5 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.19g23, 6.20g15 and 7.66g1). Note that NFPA 78 was changed to NFPA 780 by the NFPA.

II. Criteria Performance Parameter Basis

N/A

1.2.6.6 Criteria Basis Statement

I. Criteria Need Basis
Reserved.

II. Criteria Performance Parameter Basis

N/A

1.2.6.7 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.20g15 and 7.68g1)

II. Criteria Performance Parameter Basis

N/A

1.2.6.8 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.20g15 and 7.64g1)

II. Criteria Performance Parameter Basis

N/A

1.2.6.9 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.20g22 and 7.6g1)

II. Criteria Performance Parameter Basis

N/A

1.3.1.1 Reserved.

1.3.1.2 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items

6.19g3 and 6.20g3)

II. Criteria Performance Parameter Basis

N/A

1.3.1.3 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, items 6.19g2 and 6.20g2)

II. Criteria Performance Parameter Basis

N/A

1.3.1.4 Criteria Basis Statement

I. Criteria Need Basis
This criteria is derived from the regulatory precedence cited in the Compliance Package, *MGDS Compliance Package for Waste Emplacement System*. (see Table 6-1, item 6.20g5)

II. Criteria Performance Parameter Basis

N/A

5.2 SDD CRITERIA BASIS STATEMENT REFERENCES

This section presents the references used in Section 5.1.

CRWMS M&O 1998, *Bounded Minimum Inherent Availability Requirements for the System Description Documents*, DI#B0000000-01717-0200-00147, Rev 00.

CRWMS M&O, *Repository Surface Design Site Layout Analysis,* DI: BCB000000-01717-0200-00007, Rev.00.

CRWMS M&O 1996, *Engineered Barrier System Layout Calculation*, BABEAD000-01717-0200-00003, Rev. 04

CRWMS M&O 1997, *Subsurface Repository Slopes*, BCAA00000-01717-0200-00007, Rev. 00

CRWMS M&O 1997, *Repository Subsurface Layout Configuration Analysis*, BCA000000-01717-0200-00008, Rev. 00

CRWMS M&O 1997, *Controlled Design Assumptions Document.* B00000000-01717-4600-00032, Rev. 04, ICN 3. November 6, 1997. Las Vegas, Nevada

CRWMS M&O *1997,Engineering Design Climatology and Regional Meteorological Conditions Report.* B00000000-01717-5707-00066 REV 00

CRWMS M&O 1997, *Meteorological Monitoring Program, 1996 Summary Report.* B00000000-01717-5705-00072 REV 00

CRWMS M&O 1998, *MGDS Compliance Package for Waste Emplacement System,* BCA000000-01717-5600-00003, Rev. 00. Las Vegas, Nevada: Author.

YMP 1998. *Mined Geologic Disposal System Requirements Document.* YMP/CM-0025, Rev. 3. Las Vegas, Nevada:Yucca Mountain Site Characterization Office.

CRWMS M&O 1997, *Preliminary Waste Package Transport and Emplacement Equipment Design,* BCA000000-01717-0200-00012, Rev 00. Las Vegas, NV: Author

CRWMS M&O 1997, *Radiolysis/Shielding Analysis for 21 PWR Uncanistered Fuel Waste Package.* BBA000000-01717-0200-00026, Rev. 00A. Las Vegas, Nevada

CRWMS M&O 1997, *Regional and Local Wind Patterns Near Yucca Mountain.* B00000000-01717-5705-00081 REV 00.

CRWMS M&O, *Subsurface Ventilation Emplacement and Development Schematic.* BCA000000-01717-27000-86012.

CRWMS M&O 1997. *Waste Quantity, Mix and Throughput Study Report.* B00000000-01717-5705-00059 Rev 01. Las Vegas, Nevada

YMP, 1997, *Preclosure Seismic Design Methodology for a Geologic Repository at Yucca Mountain,* Topical Report YMP/TR-003-NP, Revision 2. Las Vegas, NV: Yucca Mountain Site Characterization Office.

DOE/RW 1998, Baseline Change Proposal BCP-00-98-0001, *Incorporate Plutonium Disposition Materials in CRWMS Technical Baseline.* Washington, D.C.

Dorf, R.C., 1993, *The Electrical Engineering Handbook,* CRC Press, ISBN 0-8493-0185-8

Determination of Waste Package Design Configurations. BBAA00000-01717-0200-00017, Rev. 00. April 1, 1997. Las Vegas, Nevada: U.S. Department of Energy, Civilian Radioactiye Waste Management System Management and Operating Contractor.

Precipitation-Frequency Atlas of the Western United States, Volume VII-Nevada. J.F. Miller, R.H. Frederick, and R.J. Tracey. National Oceanic and Atmospheric Administration (NOAA), U.S. Dept. of Commerce, Silver Springs, Maryland. 1973.

Preliminary Design Basis for WP Thermal Analysis. BBAA00000-01717-0200-00019, Rev. 00. September 30, 1997. Las Vegas, Nevada: U.S. Department of Energy, Civilian Radioactive Waste Management System Management and Operating Contractor.

Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages. Hydrometerological Report No. 49. National Weather Service. Prepared for U.S. Dept. of Commerce, NOAA and the U.S. Dept. of Army, Corps of Engineers. September 1977.

Safety Criteria for SDD SS-17, Waste Emplacement System, LV.SA.DDO.03/98-022, D.W. Gwyn to D. F. Smith. March 27,1998. Las Vegas, Nevada: U.S. Department of Energy, Civilian Radioactive Waste Management System Management and Operating Contractor.

Supplemental Seismic Criteria for SDDs. LV.SA.KJM.03/98-042, D.W. Gwyn to R.M. Stambaugh. March 30,1998. Las Vegas, Nevada: U.S. Department of Energy, Civilian Radioactive Waste Management System Management and Operating Contractor.

10CFR20. Energy: *Standards for Protection Against Radiation,* January 1, 1994

6.0 COMPLIANCE PROGRAM

This section presents the matrix aligning each guidance statement in the compliance program guidance package (*MGDS Compliance Package for Waste Emplacement System*) and how the guidance was incorporated into the SDD.

Table 6-1

CP Package paragraph #	Type	SDD Criteria paragraph #	Comments/Disposition
6.1i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.2i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.3i1	C	N/A - SEE NOTE 1	
6.4i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.5i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.6i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.7i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.8g1	D	N/A - SEE NOTE 2	
6.8g2	D	N/A - SEE NOTE 2	
6.8g3	D	N/A - SEE NOTE 2	
6.8g4	D	N/A - SEE NOTE 2	
6.8g5	D	N/A - SEE NOTE 2	
6.9g1	C	N/A - SEE NOTE 1	
6.10g1	C	N/A - SEE NOTE 1	
6.10g2	C	N/A - SEE NOTE 1	
6.10g3	B	1.2.3.2	
6.10g4	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.10g5	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.10g6	C	N/A - SEE NOTE 1	
6.10g7	C	N/A - SEE NOTE 1	
6.10g8	C	N/A - SEE NOTE 1	
6.10g9	C	N/A - SEE NOTE 1	
6.10g10	C	N/A - SEE NOTE 1	
6.10g11	C	N/A - SEE NOTE 1	
6.10g12	C	N/A - SEE NOTE 1	
6.10g13	C	N/A - SEE NOTE 1	
6.10g14	C	N/A - SEE NOTE 1	
6.10g15	D	N/A - SEE NOTE 2	
6.10g16	D	N/A - SEE NOTE 2	
6.10g17	D	N/A - SEE NOTE 2	
6.10g18	D	N/A - SEE NOTE 2	

6.10g19	D	N/A - SEE NOTE 2	
6.10g20	C	N/A - SEE NOTE 1	
6.10g21	D	N/A - SEE NOTE 2	
6.10g22	D	N/A - SEE NOTE 2	
6.10g23	D	N/A - SEE NOTE 2	
6.10g24	C	N/A - SEE NOTE 1	
6.10g25	C	N/A - SEE NOTE 1	
6.10g26	C	N/A - SEE NOTE 1	
6.10g27	C	N/A - SEE NOTE 1	
6.11g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.12g1	C	N/A - SEE NOTE 1	
6.12g2	C	N/A - SEE NOTE 1	
6.12g3	D	N/A - SEE NOTE 2	
6.12g4	D	N/A - SEE NOTE 2	
6.12g5	D	N/A - SEE NOTE 2	
6.12g6	D	N/A - SEE NOTE 2	
6.12g7	C	N/A - SEE NOTE 1	
6.13i1	C	N/A - SEE NOTE 1	
6.14g1	C	N/A - SEE NOTE 1	
6.14g2	C	N/A - SEE NOTE 1	
6.14g3	C	N/A - SEE NOTE 1	
6.15g1	C	N/A - SEE NOTE 1	
6.15g2	C	N/A - SEE NOTE 1	
6.15g3	C	N/A - SEE NOTE 1	
6.15g4	C	N/A - SEE NOTE 1	
6.15g5	C	N/A - SEE NOTE 1	
6.15g6	C	N/A - SEE NOTE 1	
6.15g7	C	N/A - SEE NOTE 1	
6.15g8	C	N/A - SEE NOTE 1	
6.15g9	C	N/A - SEE NOTE 1	
6.15g10	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.15g11	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.15g12	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.15g13	C	N/A - SEE NOTE 1	
6.15g14	C	N/A - SEE NOTE 1	
6.15g15	C	N/A - SEE NOTE 1	
6.15g16	C	N/A - SEE NOTE 1	
6.15g17	D	N/A - SEE NOTE 2	
6.15i1	B	N/A – SEE NOTE 3	
6.15i2	B	N/A – SEE NOTE 3	
6.15i3	B	N/A – SEE NOTE 3	
6.15i4	B	N/A – SEE NOTE 3	
6.15i5	B	N/A – SEE NOTE 3	
6.15i6	B	N/A – SEE NOTE 3	
6.15i7	B	N/A – SEE NOTE 3	

6.15i8	B	N/A – SEE NOTE 3	
6.15i9	C	N/A – SEE NOTE 1 and NOTE 3	
6.15i10	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.15i11	C	N/A – SEE NOTE 1 and NOTE 3	
6.15i12	C	N/A – SEE NOTE 1 and NOTE 3	
6.15i13	C	N/A – SEE NOTE 1 and NOTE 3	
6.15i14	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.15i15	D	N/A – SEE NOTE 2 and NOTE 3	
6.15i16	C	N/A – SEE NOTE 1 and NOTE 3	
6.15i17	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i1	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i2	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i3	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i4	C & D	N/A – SEE NOTE 1, NOTE 2, and NOTE 3	
6.16i5	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i6	C & D	N/A – SEE NOTE 1, NOTE 2, and NOTE 3	
6.16i7	C & D	N/A – SEE NOTE 1, NOTE 2, and NOTE 3	
6.16i8	C & D	N/A – SEE NOTE 1, NOTE 2, and NOTE 3	
6.16i9	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i10	C & D	N/A – SEE NOTE 1, NOTE 2, and NOTE 3	
6.16i11	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i12	C	N/A – SEE NOTE 1 and NOTE 3	
6.16i13	C	N/A – SEE NOTE 1 and NOTE 3	
6.17g1	C	N/A – SEE NOTE 1	
6.17g2	C	N/A – SEE NOTE 1	
6.17g3	C	N/A – SEE NOTE 1	
6.17g4	C	N/A – SEE NOTE 1	
6.17g5	C	N/A – SEE NOTE 1	
6.18g1	C	N/A – SEE NOTE 1	

6.18g2	C	N/A – SEE NOTE 1	
6.18g3	C	N/A – SEE NOTE 1	
6.18g4	C	N/A – SEE NOTE 1	
6.18g5	C	N/A – SEE NOTE 1	
6.18g6	C	N/A – SEE NOTE 1	
6.18g7	C	N/A – SEE NOTE 1	
6.18g8	C	N/A – SEE NOTE 1	
6.19g1	C	N/A – SEE NOTE 1	
6.19g2	B	1.3.1.3	
6.19g3	B	1.3.1.2	
6.19g4	C & D	N/A – SEE NOTE 1 and NOTE 2	
6.19g5	C	N/A – SEE NOTE 1	
6.19g6	C	N/A – SEE NOTE 1	
6.19g7	B	1.2.2.1.4	
6.19g8	C	N/A – SEE NOTE 1	
6.19g9	B	1.2.2.1.4	
6.19g10	C	N/A – SEE NOTE 1	
6.19g11	C	N/A – SEE NOTE 1	
6.19g12	C	N/A – SEE NOTE 1	
6.19g13	C	N/A – SEE NOTE 1	
6.19g14	C	N/A – SEE NOTE 1	
6.19g15	C	N/A – SEE NOTE 1	
6.19g16	C	N/A – SEE NOTE 1	
6.19g17	C	N/A – SEE NOTE 1	
6.19g18	C	N/A – SEE NOTE 1	
6.19g19	C	N/A – SEE NOTE 1	
6.19g20	D	N/A – SEE NOTE 2	
6.19g21	D	N/A – SEE NOTE 2	
6.19g22	D	N/A – SEE NOTE 2	
6.19g23	B	1.2.6.4, 1.2.6.5	
6.20g1	C	N/A – SEE NOTE 1	
6.20g2	B	1.3.1.3	
6.20g3	B	1.3.1.2	
6.20g4	C & D	N/A – SEE NOTE 1 and NOTE 2	
6.20g5	B	1.3.1.4	
6.20g6	C	N/A – SEE NOTE 1	
6.20g7	C	N/A – SEE NOTE 1	
6.20g8	C	N/A – SEE NOTE 1	
6.20g9	C	N/A – SEE NOTE 1	
6.20g10	C	N/A – SEE NOTE 1	
6.20g11	C	N/A – SEE NOTE 1	
6.20g12	C	N/A – SEE NOTE 1	
6.20g13	D	N/A – SEE NOTE 2	
6.20g14	D	N/A – SEE NOTE 2	
6.20g15	B	1.2.6.4, 1.2.6.5, 1.2.6.7, 1.2.6.8	
6.20g16	C	N/A - SEE NOTE 1	

6.20g17	B	1.2.2.1.13	
6.20g18	C	N/A - SEE NOTE 1	
6.20g19	B	1.2.2.1.4	
6.20g20	C	N/A - SEE NOTE 1	
6.20g21	C	N/A - SEE NOTE 1	
6.20g22	B	1.2.6.9	
6.20g23	C	N/A - SEE NOTE 1	
6.20g24	C	N/A - SEE NOTE 1	
6.20g25	C	N/A - SEE NOTE 1	
6.20g26	C	N/A - SEE NOTE 1	
6.20g27	C	N/A - SEE NOTE 1	
6.20g28	C	N/A - SEE NOTE 1	
6.20i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.20i2	D	N/A - SEE NOTE 2 and NOTE 3	
6.20i3	D	N/A - SEE NOTE 2 and NOTE 3	
6.20i4	C	N/A - SEE NOTE 1 and NOTE 3	
6.20i5	C	N/A - SEE NOTE 1 and NOTE 3	
6.20i6	C	N/A - SEE NOTE 1 and NOTE 3	
6.20i7	C	N/A - SEE NOTE 1 and NOTE 3	
6.21i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.22i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.23i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.24i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.25i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.26i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.27i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.28i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.29i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.30i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.31g1	C	N/A - SEE NOTE 1	
6.31g2	C	N/A - SEE NOTE 1	
6.32i1	B	N/A - SEE NOTE 3	
6.32i2	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	

6.32i3	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.33g1	B	1.2.2.1.13	
6.34g1	D	N/A – SEE NOTE 2	
6.35g1	D	N/A - SEE NOTE 2	
6.36g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.37g1	D	N/A - SEE NOTE 2	
6.38g1	C	N/A - SEE NOTE 1	
6.38g2	C	N/A - SEE NOTE 1	
6.39g1	D	N/A - SEE NOTE 2	
6.40g1	C	N/A - SEE NOTE 1	
6.41g1	C	N/A - SEE NOTE 1	
6.41g2	C	N/A - SEE NOTE 1	
6.42g1	C	N/A - SEE NOTE 1	
6.43g1	D	N/A - SEE NOTE 2	
6.44g1	B	1.2.2.1.4	
6.45g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.46g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.47g1	C	N/A - SEE NOTE 1	
6.47g2	C	N/A - SEE NOTE 1	
6.48g1	D	N/A - SEE NOTE 2	
6.49g1	C	N/A - SEE NOTE 1	
6.50g1	C	N/A - SEE NOTE 1	
6.51i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.52g1	D	N/A - SEE NOTE 2	
6.53g1	D	N/A - SEE NOTE 2	
6.54i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.55i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
6.56g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.57i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.58i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.59i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.60i1	D	N/A - SEE NOTE 2 and NOTE 3	
6.61i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.62i1	C	N/A - SEE NOTE 1 and NOTE 3	
6.64g1	C & D	N/A - SEE NOTE 1 and NOTE 2	

6.65g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
6.67g1	C	N/A - SEE NOTE 1	
6.67g2	C	N/A - SEE NOTE 1	
6.67g3	C	N/A - SEE NOTE 1	
6.67g4	B	1.2.2.1.11	
6.68g1	C	N/A - SEE NOTE 1	
6.69g1	C	N/A - SEE NOTE 1	
7.1g1	C	N/A - SEE NOTE 1	
7.2g1	C	N/A - SEE NOTE 1	
7.2g2	C	N/A - SEE NOTE 1	
7.3g1	C	N/A - SEE NOTE 1	
7.4g1	C	N/A - SEE NOTE 1	
7.4g2	C	N/A - SEE NOTE 1	
7.5g1	C	N/A - SEE NOTE 1	
7.6g1	B	1.2.6.9	
7.7g1	C	N/A - SEE NOTE 1	
7.8g1	C	N/A - SEE NOTE 1	
7.8g2	C	N/A - SEE NOTE 1	
7.9g1	C	N/A - SEE NOTE 1	
7.9g2	C	N/A - SEE NOTE 1	
7.9g3	C	N/A - SEE NOTE 1	
7.9g4	C	N/A - SEE NOTE 1	
7.10g1	C	N/A - SEE NOTE 1	
7.10g2	C	N/A - SEE NOTE 1	
7.11g1	C	N/A - SEE NOTE 1	
7.11g2	C	N/A - SEE NOTE 1	
7.11g3	C & D	N/A - SEE NOTE 1 and NOTE 2	
7.11g4	C	N/A - SEE NOTE 1	
7.13g1	C	N/A - SEE NOTE 1	
7.15g1	C	N/A - SEE NOTE 1	
7.16g1	C	N/A - SEE NOTE 1	
7.16g2	C	N/A - SEE NOTE 1	
7.16g3	C	N/A - SEE NOTE 1	
7.16g4	C	N/A - SEE NOTE 1	
7.17g1	C	N/A - SEE NOTE 1	
7.17g2	C	N/A - SEE NOTE 1	
7.18g1	C	N/A - SEE NOTE 1	
7.18g2	D	N/A - SEE NOTE 2	
7.18g3	D	N/A - SEE NOTE 2	
7.18g4	D	N/A - SEE NOTE 2	
7.19g1	C	N/A - SEE NOTE 1	
7.20g1	C	N/A - SEE NOTE 1	
7.21g1	D	N/A - SEE NOTE 2	
7.21g2	D	N/A - SEE NOTE 2	
7.22g1	C	N/A - SEE NOTE 1	
7.23g1	C	N/A - SEE NOTE 1	

7.24g1	C	N/A - SEE NOTE 1	
7.25g1	C	N/A - SEE NOTE 1	
7.26g1	D	N/A - SEE NOTE 2	
7.27g1	D	N/A - SEE NOTE 2	
7.28g1	D	N/A - SEE NOTE 2	
7.29g1	C	N/A - SEE NOTE 1	
7.30g1	C	N/A - SEE NOTE 1	
7.31g1	C	N/A - SEE NOTE 1	
7.32g1	C	N/A - SEE NOTE 1	
7.33g1	C	N/A - SEE NOTE 1	
7.35g1	C	N/A - SEE NOTE 1	
7.36i1	C	N/A - SEE NOTE 1 and NOTE 3	
7.36i2	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTe 3	
7.38g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
7.38g2	C & D	N/A - SEE NOTE 1 and NOTE 2	
7.39g1	C & D	N/A - SEE NOTE 1 and NOTE 2	
7.40i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
7.41i1	B	N/A - SEE NOTE 3	
7.41i2	D	N/A - SEE NOTE 2 and NOTE 3	
7.42g1	D	N/A - SEE NOTE 2	
7.43i1	B	N/A - SEE NOTE 3	
7.43i2	B	N/A - SEE NOTE 3	
7.43i3	B	N/A - SEE NOTE 3	
7.43i4	C	N/A - SEE NOTE 1 and NOTE 3	
7.45g1	D	N/A - SEE NOTE 2	
7.45g2	D	N/A - SEE NOTE 2	
7.46i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.47g1	D	N/A - SEE NOTE 2	
7.48g1	D	N/A - SEE NOTE 2	
7.49i1	C	N/A - SEE NOTE 1 and NOTE 3	
7.49i2	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
7.50g1	D	N/A - SEE NOTE 2	
7.51i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.52i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.53i1	C	N/A - SEE NOTE 1 and NOTE 3	
7.54i1	C	N/A - SEE NOTE 1 and	

		NOTE 3	
7.55i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.56i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.57i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.58i1	D	N/A - SEE NOTE 2 and NOTE 3	
7.59i1	C	N/A - SEE NOTE 1 and NOTE 3	
7.60g1	D	N/A - SEE NOTE 2	
7.61i1	C & D	N/A - SEE NOTE 1, NOTE 2, and NOTE 3	
7.62g1	C	N/A - SEE NOTE 1	
7.63g1	C	N/A - SEE NOTE 1	
7.64g1	B	1.2.6.8	
7.65g1	B	1.2.6.4	
7.66g1	B	1.2.6.5	
7.67g1	B	N/A - SEE NOTE 1	
7.68g1	B	1.2.6.7	
7.69i1	C	N/A - SEE NOTE 1 and NOTE 3	
7.70i1	C	N/A - SEE NOTE 1 and NOTE 3	
Note 1: The compliance guidance identified in this paragraph of *MGDS Compliance Package for Waste Emplacement System* should be used in Design Guides, and considered in the design of this System.			
Note 2: The compliance guidance identified in this paragraph of *MGDS Compliance Package for Waste Emplacement System* should be considered for use in M&O programmatic related activities.			
Note 3: The compliance guidance identified in this paragraph of *MGDS Compliance Package for Waste Emplacement System* should not be considered for use at this time.			

APPENDIX A FUTURE REVISION RECOMMENDATIONS & CONSIDERATIONS

1.0 Purpose

The purpose of this section is to document issues and actions that shall be considered in future revisions of the SDD. The use of this information will be used to further enhance the development of the SDD during the life cycle of this system. As the system criteria and design description matures, the usefulness of this section will become minimized. However, in the early phase of development of this SDD, this section will serve as a valuable tool.

2.0 Future Revision Recommendations & Considerations

2.1. Add requirements to identify and bound instrumentation and control system interfaces.

2.2 Add requirements to bound system reliability.

2.3. Add requirements to bound requirements for system maintenance.

2.4 Add requirements to address inputs from the planned Interface Control Documentation for interfaces with the disposal container and other systems.

2.5 Address Material Control and Accountability criteria.

2.6 Address radiation exposure for personnel, maintenance, etc. criteria.

2.7 Address the specifics on how frequency and acceleration (horizontal and vertical) data will be presented as seismic criteria.

2.8 Address Maintainability criteria.

2.9 Address Maintenance criteria.

2.10 Address Human Factors criteria.

2.11 Address Surveillance, In-Service Inspections, and Testing criteria.

2.12 Address Reliability criteria for safety systems.

2.13 Address National Codes and Standards related to EMI and protection (including electro-magnetic susceptibility, radiated emissions, over voltage and surge protection, etc.).

2.14 Resolve TBD and TBV parameters in the criteria.